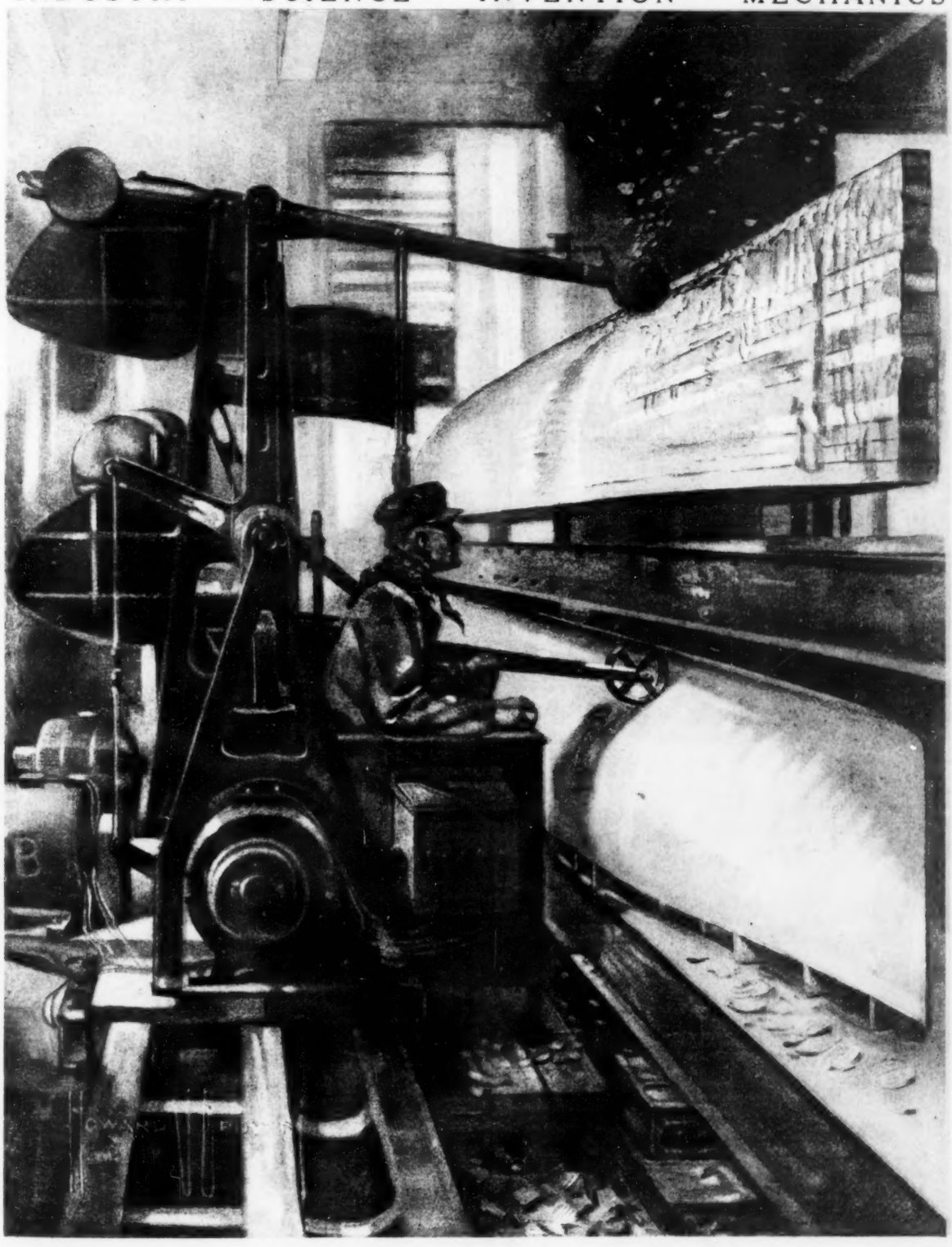
IN THIS ISSUE:

LUBRICATING THE WORLD
DESCENDANTS OF THE WATER-WHEEL

SCIENTIFIC AMERICAN

A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS



SHAPING A MODEL SHIP BY MEANS OF THE MODEL CUTTING MACHINE.—[See page 90]

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"Say Pop, when are you going to get through?"

How the correct grade of Gargoyle Mobiloils cuts down Sunday morning tinkering

SUNDAY morning, clear and cool; the week-end guests on hand; and the open road beckoning—

And then the endless Sunday morning tinkering while the family and guests walk impatiently up and down the lawn. *"When are you going to get through?"*

If you have to clean your spark plugs at frequent intervals, the chances are that you are using lubricating oil of incorrect body or low quality *"When are you going to get through?"*

If the compression is weak and your engine seems to lack power, it is probably because your oil fails to properly seal the piston rings. Results:—weak compression, loss of power, and dilution of lubricating oil. *"When are you going to get through?"*

The loss of power and irregular action may be due to sticky valves. Sticky valves usually result from the use of the wrong oil. *"When are you going to get through?"*

REPAIR SHOP RECORDS show that about 50% of all engine troubles are caused by incorrect lubrication.

These troubles are by no means confined to the three mentioned above. Other troubles commonly caused by incorrect lubrication are—piston-rings badly gummed or stuck in their recesses, smoky exhaust, worn wrist-pin or crank shaft bearings, scored cylinder walls, engine overheated, carbon deposit and pre-ignition.

The motorist who uses the grade of Gargoyle Mobiloils specified for his car enlists *scientific lubrication* on his side and cuts down Sunday morning tinkering.

"When are you going to get through?"

GARGOYLE

Mobiloils

A grade for each type of Motor

Correct
AUTOMOBILE LUBRICATION

GARGOYLE

Mobiloils

A grade for each type of motor

Gargoyle Mobiloils for engine lubrication are:

Gargoyle Mobiloil "A"
Gargoyle Mobiloil "B"
Gargoyle Mobiloil "BB"
Gargoyle Mobiloil Arctic

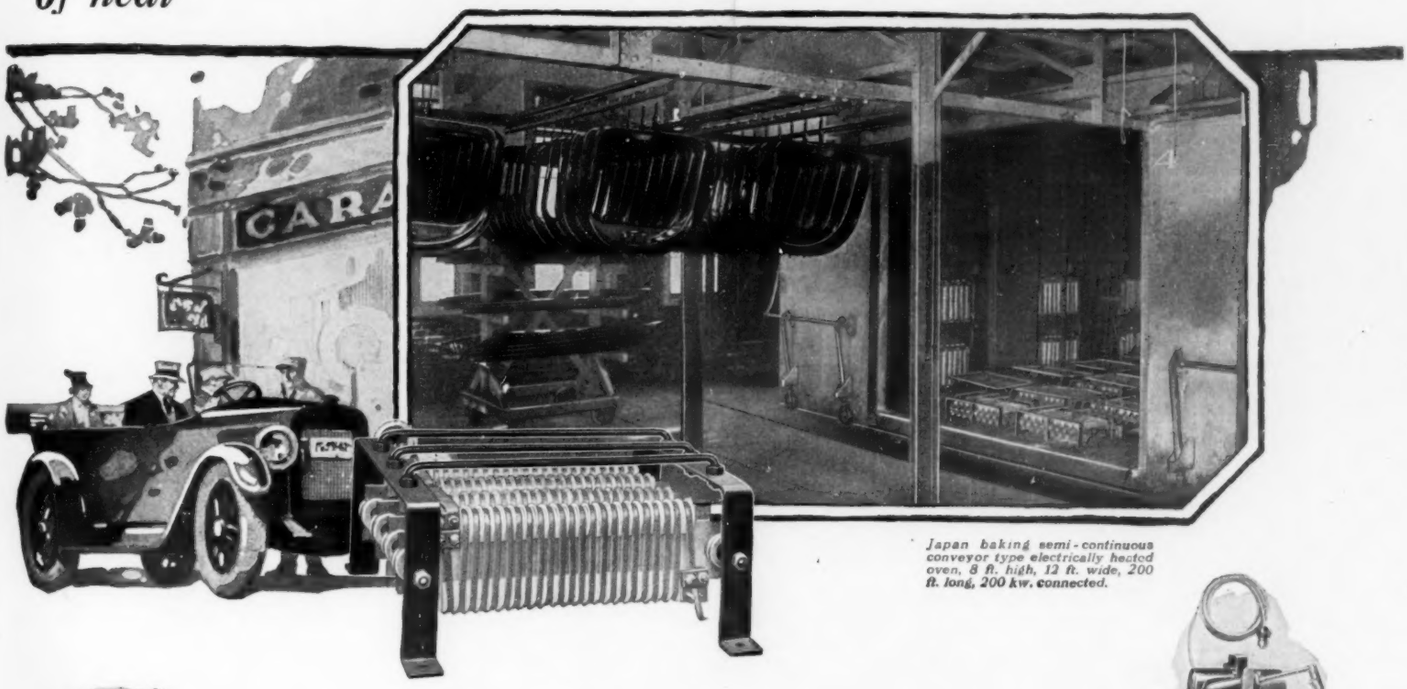
The Chart below indicates the grade recommended by the Vacuum Oil Company's Board of Engineers. The recommendations cover all models of both passenger and commercial vehicles unless otherwise noted. If your car is not listed in this partial Chart, send for booklet "Correct Lubrication" which lists the correct grades for *all* cars.

AUTOMOBILES	1913 Models		1912 Models		1911 Models		1910 Models		1909 Models	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Allen	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Auburn (4 cyl.)							A	Arc	A	Arc
Auburn (6 cyl.)	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Auburn (6-55)						A	Arc			
" (6-39)-Touring-H			A	Arc						
Autocar (2 cyl.)	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Briscoe	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
" (8 cyl.)							A	A		
Buick	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Cadillac (8 cyl.)	A	A	A	A	A	A	A	A	Arc	Arc
Case	Arc	Arc	Arc	A	A	Arc	Arc	Arc	A	Arc
Chalmers			A				Arc	Arc	Arc	Arc
" (Sept)				A			A	A		
" (6-50)	A	A			A	A	A	A		
Chandler Six	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Chevrolet	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" (8 cyl.)	A	A	A	A	A	A				
" (F A.)	A	Arc	A	Arc						
Cole							Arc	Arc	Arc	Arc
" (8 cyl.)	A	A	A	A	A	A	A	A	A	A
Cunningham									Arc	Arc
" (8 cyl.)	A	A	A	A	A	A	A	A		
Dart	Arc	Arc	A	Arc	A	Arc	A	Arc	Arc	Arc
" (Model C)					A	Arc	A	Arc	A	Arc
" (2 and 3½ ton)	A	A	A	A						
Dodge Brothers	A	Arc	A	Arc	A	Arc	A	Arc	E	E
Dort	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Federal	Arc	Arc	A	A	Arc	Arc	Arc	Arc	Arc	Arc
" (Mod. 5-X)			A	A						
Federal (special)			Arc	Arc						
Fiat			B	A	B	A	B	A	B	A
Ford	E	E	E	E	E	E	E	E	E	E
Franklin	A	A	A	A	A	A	A	A	A	A
Grant	A	Arc	A	Arc	A	Arc	A	Arc	Arc	Arc
" Com'l	Arc	Arc								
" (Model 12)	A	Arc								
Haynes	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
" (12 cyl.)	A	A	A	A	A	A	A	A		
Hudson			Arc	Arc	A	Arc	A	Arc	Arc	Arc
" 7 Super Six	A	Arc	A	Arc	A	Arc	A	A		
Hupmobile	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Kelly Springfield	A	A	A	A	A	A	A	A	A	A
King									A	Arc
" (8 cyl.)	A	A	A	A	A	A	A	A	A	Arc
" Commercial			Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Kissel Kar	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
" (Model 48)							A	A	A	A
" (12 cyl.)			A	A	A	A				
Lexington	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Liggett Spencer			Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" (Mod. M)					A	Arc	A	Arc		
" (Mod. MW					A	Arc				
Locomobile	A	E	A	E	E	E	E	E	E	E
McFarlan			A	A	A	Arc	A	A	A	Arc
McLaughlin	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
McLaughlin (Mod. E6)	A	A	A	A						
Marmon			A	A	A	Arc	A	A		
" (8 cyl.)					A	A	A	A		
Marmon	A	A	A	A	A	A	A	A	A	Arc
Maxwell	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Mercer	A	A	A	A	A	A	A	A	A	Arc
" (35-70)									A	Arc
Mitchell	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
" (8 cyl.)							A	A		
Moline-Knight	B	A	B	A	A	A	A	A	A	A
Monroe			A	Arc	A	Arc	E	E	A	Arc
" (Mod. M4)			A	A	A	A				
" (Mod. S)	A	A								
Mora			Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Nash	A	Arc								
" (Mod. 671)			A	A						
" (Quad)	A	A	A	A						
National	Arc	Arc	Arc	Arc	Arc	Arc	A	Arc	A	Arc
" (12 cyl.)	A	A	A	A	A	A	A	A		
Nelson	A	A	A	A	A	A				
Oakland	A	A	A	A	Arc	Arc	Arc	Arc	Arc	Arc
" (8 cyl.)							Arc	Arc		
Oldsmobile (4 cyl.)	A	Arc					Arc	Arc	Arc	Arc
" (6 cyl.)	A	A	A	A	Arc	Arc			Arc	Arc
" (8 cyl.)	A	A	A	A	A	A	A	A		
Overland	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Packard					A	A	A	A	A	A
" (12 cyl.)	A	A	A	A	A	A				
" Commercial	A	A	A	A	A	A	A	A	A	A
Paige (4 cyl.)									A	A
" (6 cyl.)	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" (6-50)							A	Arc	A	Arc
" (6-38-50)					A	Arc				
" (6-40)	A	Arc	A	Arc						
Paige (Com'l)	Arc	Arc	Arc	Arc						
Pierce-a	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Peerless			Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" (8 cyl.)	A	A	A	A	A	A	A	A		
Pierce Arrow	A	A	A	A	A	A	A	A	Arc	Arc
" " Com'l	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Premier	A	A	A	A	A	A	A	A	A	Arc
Regal	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
(8 cyl.)					A	A	A	A	Arc	Arc
Renault (French)					A	A	A	A	A	Arc
Reo	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Rikar	A	E	A	E	E	E				
Saxon	E	E	E	E	E	E	E	E	E	E
Selden	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" (½ ton)					A	Arc				
Simplex (Crane	A	A	A	A	A	A	A	Arc	Arc	Arc
Stearns-Knight	B	A	B	A	A	A	B	A	B	A
Studebaker	A	Arc	A	Arc	A	Arc	A	Arc	Arc	Arc
Stutz	A	A	A	A	A	A	A	A	A	A
Velie (4 cyl.)									A	Arc
" (6 cyl.)	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" (1 ¾ ton)	Arc	Arc	Arc	Arc						
" (½ ton)	A	A	A	Arc						
Westcott	Arc	Arc	Arc	Arc						
White	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" (Sixteen Valve)	A	A	A	A	A	A				
White (3 ton)	A	A	Arc	Arc						
Willys-Knight	B	B	B	A	A	A	B	A	B	A
Willys Six	Arc	Arc	Arc	Arc	Arc	Arc				
Winton	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc

Domestic Branches: New York, Philadelphia, Pittsburgh, Indianapolis, Des Moines, Boston, Chicago, Detroit, Minneapolis, Kansas City, Kan.

VACUUM OIL COMPANY *Specialists in the manufacture of high-grade lubricants for every class of machinery. Obtainable everywhere in the world* NEW YORK, U.S.A.

Five years ago electric heat was somewhat of a novelty—today it is doing what was then considered impossible with any kind of heat



Japan baking semi-continuous conveyor type electrically heated oven, 8 ft. high, 12 ft. wide, 200 ft. long, 200 kw. connected.

Compound melting pot

Electric soldering iron

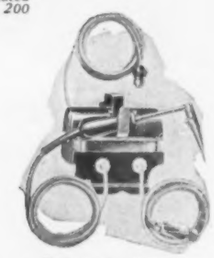
Electrically heated glue pot

Beautiful Bodies Help Sell Motor Cars

ANY motor car builder will admit that a large number of cars is sold on "looks." As a result, the finishing of bodies and all enameled parts such as fenders, wheels, tanks, etc., is a process that requires most careful consideration and the best equipment available. In this process, the electric oven has come to the front through its obvious advantages over old-fashioned methods of baking. Its use greatly increases production, thereby reducing the unit cost, even with higher rates for power than for fuel. Electric heat produces a lustrous, hard finish so essential for lasting beauty, and it requires less time than other forms of heat, with more accurate control, greater safety, and practically no defective work that must be done a second time.

The flexibility of electric heat is remarkable since it permits the use of varying degrees of heat in different parts of the same oven or furnace. For this reason, electric heat is rapidly being applied to the baking of varnish, enamel, japan, and other finishes; to the melting of metals and alloys; to the heating of steel so that it may be chemically treated; to the drying of salts, sand cores, pottery and grinding wheels; to the heating of rivets, soldering irons, etc.; and even to the sherardizing of steel to make it rustproof by depositing on its surface a coating of zinc about twenty-five ten-thousandths of an inch thick.

To every one of the many uses of electric heat the General Electric Company has contributed in a broad way, until today the mark G-E on any electric heating device is the mark of the master. Thus it is to any manufacturer's advantage to consult G-E engineers before selecting such equipment.



Pyrotip lead burner

Cartridge type electric heating unit

Soldering iron muffle furnace

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

39-40

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Working day and night

"After running 218 miles per day (24 hours), 7 days a week for 31 consecutive weeks, this 5½-ton Mack is now making daily round trips from New York to Philadelphia—piling up an almost unbelievable mileage record."—*From one letter of hundreds we should like you to read.*

AXLES of drop-forged chrome nickel steel, springs of heavy silico-manganese steel, and a flexible, hot riveted, pressed steel frame—these Mack details make capacity deliveries over long routes both practicable and profitable. Distinctive Mack engineering features, combined with 18 basic Mack patents, have developed the motor truck the world is talking about.

Capacities, 1½ to 7½ tons. Tractors to 15 tons
Full information upon request

INTERNATIONAL MOTOR COMPANY OF NEW YORK

Mack TRUCKS

"PERFORMANCE COUNTS"

SEVENTY-SIXTH YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CXXIII. NUMBER 4] NEW YORK, JULY 24, 1920 [15 CENTS A COPY 20 CENTS IN CANADA

Bird's-eye view of Long Island looking toward New York City, showing the grounds, antennæ system and building of the New York Radio Central Station to be constructed

The Last Word in Wireless—The New York Radio Central Station

FOR more than two decades the wonders of wireless have so unceasingly intrigued the public imagination that it would appear little remained to be accomplished in developments of revolutionary character. Yet, once again, it is disclosed that a startling conception in wireless communication has been quietly brought to a point of realization. On the north shore of Long Island, near New York, a leading American radio company is about to begin construction of a super-powered radio station that will simultaneously send to and receive messages from five great nations of other continents.

The new and great medium of far-reaching economic and political influence will bear the name of *New York Radio Central Station*, the steel towers of which will rise on a 6,400-acre tract, comprising nearly ten square miles of land lying east of Port Jefferson, with a long frontage on Long Island Sound. The preliminary engineering studies have been completed, contracts for all the construction materials are being let, and a force of radio experts, after months of preparation, will immediately take the big job in hand.

A definite idea of the ultra-modern character of this radio plant may be gained from the observations of Edward J. Nally, president of the Radio Corporation of America (a combination of the General Electric Company and the former Marconi Company) under whose direction the world wide wireless system has emerged from an idea into a reality. "Everyone at all familiar with wireless," said Mr. Nally, "knows that at Nauen, Germany, and Bordeaux, France, are two of the largest stations in the world. Up to now they have been viewed with admiration; consider, then, the tremendous advance represented in this latest step: the New York Radio Central Station in the aggregate will be five times more powerful than either of these."

He explained that there will be five complete transmitters, each one a duplex unit with a corresponding receiving station located near by. All five transmitters and the five receivers will operate simultaneously and will transmit and receive messages over thousands of miles continuously day and night.

The form of aerial construction, too, is wholly a new departure. From the central power house six spans of aerial wire will radiate out in a star pattern to a distance of more than one mile from the center. The wires of this huge antenna will be supported on self-supporting steel towers, each 400 feet in height, with the wires suspended at the top between 150-foot cross arms. Each of the six antennæ will have twelve towers, forming so to speak the spokes of a giant wheel fashioned out of seventy-two miniature replicas of the famous Eiffel Tower in France. Five of these antennæ spokes will be used for regular service while the sixth is reserved for emergency operation.

Far more impressive than physical appearance, however, will be the things the eye cannot encompass. Appreciate, that in the wires forming each spoke of the gigantic wheel there will be generated a power equal to the greatest of present day transoceanic wireless stations; then comprehend, if you can, the fact that all five of these powers can, if desired, be combined into one, for signaling. A telegraphic signal created out of such tremendous electromagnetic energy could encircle the entire globe!

But that is not all. The apparatus and system which will be installed for each of the five units will be the same as that at present in our New Brunswick (N. J.) station from which the voice of Secretary of the Navy Daniels was carried to President Wilson when he was at sea aboard the U.S.S. "George Washington." In a number of experimental tests the voice has been carried by this radio telephone over distances of 2,500 miles with complete success. This leads us to state very definitely that before long a direct wireless telephone service will be established with foreign countries.

Every exacting requirement of commercial radio message service will be satisfied fully in the apparatus and system of circuits with which the great station will be equipped. The generation of the energy required to span thousands of miles will be effected by Alexanderson alternators, which have made it possible to carry the radio signals through space by continuous wave trains instead of by the interrupted or discontinuous waves generated by systems using the old-time "spark discharge" apparatus. In the Alexanderson alternator equipment the new station will have a source of energy proven as reliable as the power dynamo, yet creating a steady stream of electromagnetic oscillations, which will permit telegraphic signaling at very high speeds.

So efficient and reliable has the Alexanderson 200-kilowatt alternator installed at New Brunswick proven itself, that leading radio experts of Europe have made special trips of investigation to the United States to view its performance; now this already famous single

(Continued on page 92)

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

A Real Start in Aeronautics

WE cannot commend too highly the plans of the Post Office Department for establishing, in addition to its own transcontinental airplane service between New York and San Francisco, four other routes between leading cities of the country, which are to be operated by private contract. Congress has made an appropriation of over one million dollars for the service to be operated by the Post Office Department from New York City by way of Cleveland, Chicago and Omaha, to San Francisco. The first routes to be established by the Government will be those for which the Post Office Department is now asking bids, as follows:

Cleveland-Detroit, 95 miles by air; 1,000 pounds of mail per trip. Pittsburg-St. Louis, 600 miles; 1,500 pounds of mail. New York-Pittsburgh-Chicago, 735 miles; 1,500 pounds of mail. New-York-Atlanta, 815 miles; 1,500 pounds of mail. In each case one trip each way 306 days in the year, with leading intermediate stops (except, of course, between Cleveland and Detroit).

In drawing up the specifications the Post Office has been able to call upon its own extended experience during the two years' operation of its air mail service, and it states that any type of modern airplane can easily perform the service.

In a recent issue we quoted from a paper lately read by Colonel Vincent, in which he stated that the most practicable way for the Government to promote commercial aviation in the United States would be by the extension of its air mail service. This it is now about to do, and on a scale that will vigorously stimulate what threatened to become a moribund industry. To set up these five great routes and maintain them will call for a large and steady output of airplanes, and we have no doubt that the states and cities affected will come forward with generous assistance in providing the necessary sites for the many landing fields that must be provided.

If this great venture shall prove to be a success—and the Department would never have launched out so boldly unless its two years' experience gave good promise of success—we may look for an eventual revival of our airplane industry upon a steadily increasing scale.

About That Einstein Prize

SOMEBODY has asked us what we hope to accomplish by the five-thousand-dollar prize competition which we announced two weeks ago. Our interrogator points out that for five to ten years the Einstein theories have been quite familiar to those mathematicians whose interest lay in the field which would draw their attention to this work. He calls our personal attention to the fact that as long ago as 1914 we were in the habit of dodging discussion with him of the mathematical aspects of relativity. He points out that since the incident of the eclipse several books on the subject have appeared, to say nothing of a quantity of magazine articles. His general viewpoint seems to be a doubt that anything can be done in a three-thousand-word essay which has not been done in one or several of these.

It is in the thought that this viewpoint may be somewhat general that we write these few words. We have not the slightest idea that the essay competition is going to bring out any new knowledge, that the winner or any of the other contestants will be able to say anything about the Einstein theories that is not already a matter of knowledge and of record. But that is not the point.

Of all these books, we should say that Dr. Eddington's is most nearly complete and possessed of greatest scientific value, and that Dr. Slosson's has the best appeal to the reader who is not versed in the devious ways of those mathematical fields that make the calculus look like the merest elements of the subject. But in both these books there are plenty of places that are pretty tough reading; we do not believe that anyone not a mathematician can read through either book conscientiously without getting lost more or less frequently.

An essay of three thousand words is not long enough to lose a reader more than once; if it does lose him it is a failure, and if it doesn't it is a competitor that will go into the final elimination trials for the prize. If we can present, as a result of the contest, six or a dozen essays of this length that will not lose the lay reader at all, we shall have produced something amply worth the expenditure of Mr. Higgins' money and our time. For such a number of essays of such character will of necessity present many different aspects of the Einstein theories, and in many different ways, and in doing so will contribute greatly to the popular enlightenment.

Really the significant part of what has already appeared is not the part that is intelligible, but rather the part that, being unintelligible, casts the shadow of doubt and suspicion on the whole. The successful competitor for the prize and his close contestants will have written essays that, without any claim to completeness, will emphasize what seems to each author the big outstanding feature; and every one of them will be intelligible. Together they will in all probability be reasonably complete, and will retain the individual characteristic of intelligibility. They will approach the various parts of the field from various directions—we could fill this page with suggestions as to how the one item of the four-dimensional character of Einstein's time-space might be set forth for the general reader. And when a man must say in three thousand words as much as he can of what eminent scientists have said in a whole volume—well, the result in some cases will be sheer failure, and in others a product of the first water. The best of the essays will shine through intelligent selection of what is to be said, and brilliant success in saying it. It is to get a group of essays of this character, not to get new knowledge of relativity, that the prize is offered.

General Crozier on Our Ordnance Effort

NO phase of our preparation for the war attracted so much attention as the provision of ordnance for our rapidly forming armies. It is not generally known that ordnance constituted by far the largest single item of expense. The Bureau of Ordnance had on its books on the date of the armistice some fourteen billions of dollars of which, if we remember rightly, nearly one-half was expended. Naturally the citizen will ask: "Why were these enormous sums necessary? And why was it, with funds so lavishly provided, that we were so largely dependent upon our allies for field and heavy artillery, and, in less measure, at the outset of our field operations, for rifles and machine guns?" The answer to these questions is given in a very clear, precise and straightforward way by Major General William Crozier, Chief of the Bureau of Ordnance, now retired, in a book entitled "Ordnance and the World War." "Everybody now knows," says the author, "that we entered the war with a very small army and a totally inadequate supply of arms, ammunition and other equipment. But there are some who do not know why it took so long a time to raise the war army and transport it to Europe, or why its supply of certain American-made munitions was so long delayed."

The public, in a spirit of good sportsmanship, if we may put it that way, should welcome a work of this kind from any military man whose administration has been subjected to criticism; he is prevented, while in the service, from telling the simple facts which would set him right in the eyes of the nation. There is a world of meaning in the last clause of the introductory chapter in which the General says: "I should add that, having retired from active service, I am no longer a part of the War Department or of the Army with the Colors. I therefore speak without official authority, and with something of the freedom of any other citizen."

Naturally, the chapters dealing with machine guns will attract the most attention, this because of the long controversy which raged around the question of the delay in the adoption of the Lewis machine gun. General Crozier has adopted the wise course of giving a succinct statement of the various tests which were made by the War Department of the various types of machine guns, including the Lewis gun, offered to the Government, and the facts as thus presented will enable any civilian to judge for himself the merits of the case.

Because these weapons operate with tremendous pressure and enormous velocity of moving parts, the General tells us that "no entirely satisfactory machine gun has yet been developed, that is to say, we have never had a machine gun that is not subject to stoppage by reason of some kind of malfunction," although the Browning gun is a great advance in this respect. Speaking of the service rendered, he says that the Benet-Mercier gives out about one horse-power for each pound of its weight, which is approximately double the output per pound of the Liberty engine.

In 1913 the Ordnance Department arranged a competitive test of automatic machine rifles at which all of the seven competing guns were eliminated except the Benet-Mercier and the Vickers; and in the subsequent field test, in the spring of 1914, the Vickers gun was selected. The report stated that in the endurance test there were with the Lewis gun 206 jams and malfunctions; with the Vickers gun, 23; and with the Benet-Mercier, 59. The next test took place at the Springfield Armory in April, 1916, when the service gun was withdrawn by the makers on the ground that it was in an experimental stage. The War Department Board found that the Lewis gun, in its then stage of development, was not as reliable as the other guns tested, the number of jams and malfunctions of the Lewis gun being 314 as against 59 of the Springfield and 23 for the Vickers gun, the duration of the firing being respectively 123 minutes, 147 minutes and 84 minutes. "The Lewis gun," the report goes on to say, "is lighter, simpler, and has a fewer number of parts than the other guns mentioned." These results were borne out by experience had on the Mexican border in the same year. General Crozier quotes a report of the School of Musketry as saying, "The Lewis gun, while it is not a dependable weapon at present, is believed to possess great possibilities."

As a matter of fact the interests which had the Lewis gun in hand during this period were turning out a very much better weapon in Great Britain than they were in this country, and it was only a question of time when the Lewis gun would be found available for our own service. As General Crozier says, "It must be remembered that no Lewis gun, as made in England for the British service, had ever been available in the United States, even for test." He tells us that throughout the winter and in the early spring of 1917, over fifteen important changes had been made in the gun. That it had now been brought to a state of practicability for use with American ammunition was shown by a test held under the auspices of the Navy Department. Consequently, after our entrance into the war and as soon as funds were available, the Ordnance Department ordered 4,400 Lewis guns, and after a test by the War Department Machine-Gun Board in May, 1917, they reported that the Lewis machine gun, caliber .30, fully established its character as a first-class machine gun. Following this report, Lewis guns were ordered as funds became available.

When our plants had been established and were going at full pressure, the output of machine guns and automatic rifles of the Vickers, Lewis, Colt-Marlin and Browning types was 180,000 at the date of the armistice, and our rate of manufacture reached a point such as to remove all fear that our troops might lack a sufficient number of weapons of this class.

Electricity

Electric Shock Aid.—The National Safety Council of Chicago, Ill., has issued a large wall bulletin suitable for putting on the walls of power houses and central-station buildings, giving the rules adopted by the National Electric Light Association for using the prone pressure method of resuscitation for electric shock. The bulletin is illustrated with three cuts showing the application of the treatment. The council has also issued pamphlet No. 29, entitled "Electrical Equipment in Industrial Plants," which, according to a subtitle, is "an orderly presentation in loose-leaf form of ancient hazards and the best practises for their elimination."

VibrationGalvanometers are useful in null measurements but have not been used in industrial laboratories because they are sensitive to external vibrations and require delicate adjustments. The present instrument, which has a sensitivity higher than other forms of the moving-iron type but less than that of the most sensitive forms of the moving-coil type, has the advantages of sturdiness, quick responsiveness and freedom from the effects of external vibration. It consists essentially of a fine steel wire mounted on one pole of a permanent magnet and so arranged that the free end of the wire may vibrate between the poles of an electromagnet through which the current to be detected passes.

Cadmium-Vapor Arc Lamp.—The Bureau of Standards, Washington, D. C., has announced, through Scientific Paper No. 371, the development of a new method of producing a cadmium vapor arc of great brilliancy. It was found that the metal gallium alloyed with cadmium, and since gallium has a boiling point above 1,500°C., the vapor-pressure relation which exists between cadmium and mercury is reversed when compared with cadmium and gallium. The cadmium therefore acts as the energy carrier when used in combination with gallium in a quartz lamp. The cadmium-vapor lamp may be operated with a current of three amperes and a drop of 14 volts across the terminals, but gives the best results when operated at about 25 volts. Under this condition a practically pure cadmium spectrum is obtained. The lamp is expected to fill a demand for a light source of this character.

Resistance for Rheostats.—Where resistances are formed of spirals of wire, the sections of the wires must be so determined that the cooling surface per unit of power is constant, depending on cooling conditions. In an article appearing in a French periodical, it is demonstrated mathematically how a saving of metal may be effected by using several wires in parallel instead of a single one. The volume and, consequently, the weight of wire used for the resistance, is the less the more wires in parallel are used; a resistance formed of a single wire weighs 3.3 times as much as the same resistance of six wires in parallel. Of course, the dimensions of the rheostat and the cost of labor increase with the number of wires, so that there is an economic number for each case. If the resistances are formed of bands of very thin wires, with which the section is proportional to current density, the weight of metal is constant whatever the number of conductors in parallel, so that it is usually best to take a single conductor.

Double-Base Incandescent Lamp.—A new double-base lamp by means of which household appliances and fixtures may be used simultaneously from the same outlet without the use of double plugs or adapters has been developed by E. O. Schweitzer, chief testing engineer of the Commonwealth Edison Company of Chicago. The lamp may be made up in any style and capacity. The lead-in wires are those used for the standard 500-watt lamp and continue through the bulb from base to base, the lamp filament being tapped off from them. The lead-in wires, which are formed into an expansion loop to eliminate strain due to unequal contraction and expansion of the lamp elements, are made with a quarter twist to provide clearance for the filament anchors. Exhaustion is carried out through a concealed tube within one of the bases, continues *Electrical World*, thus making a tipless lamp. By the addition of a light brass shell beaded at each end any standard shade holder may be used. The extra attachment to the lamp may be made by using a socket screwed to its free base.

Science

A Board of Surveys and Maps has been created by executive order, for the purpose of coördinating the activities of the map-making agencies of the United States Government.

A Notable Contribution to Palæobotany is Dr. F. H. Knowlton's "Catalogue of the Mesozoic and Cenozoic Plants of North America," published as U. S. Geological Survey Bulletin 696. The work contains bibliographic references to about 735 genera and about 4150 named species and varieties of plants found in the Mesozoic and Cenozoic of the United States and Canada, and makes a ponderous volume. The bibliography contains 474 titles.

The Leucoscope in Pyrometry.—The Bureau of Standards has recently been making experiments with the leucoscope, an instrument devised many years ago by Helmholtz for light and color analysis, and finds that this instrument, originally used in the study of vision, has useful applications in pyrometry. New laws have been discovered, relating the readings of the instrument to temperature and spectral energy distribution in a light source or furnace. The results of this investigation have been communicated to the Optical Society of America, for publication in its journal.

The American Geophysical Union.—The American section of the International Geophysical Union, which met in Brussels in July, 1919, has recently been reorganized and enlarged to form the American Geophysical Union. It is divided into six sections, which, with their chairmen, are as follows: (a) Geodesy, William Bowie; (b) seismology, H. F. Reid; (c) meteorology, C. F. Marvin; (d) terrestrial magnetism and electricity, L. A. Bauer; (e) physical oceanography, G. W. Littlehales; (f) volcanology, H. S. Washington. The secretary of the Union is Prof. Harry O. Wood, of Johns Hopkins University.

Improvements in Map Projections.—The U. S. Coast and Geodetic Survey has been devoting much attention of late to the subject of map projections, and has issued several interesting memoirs relating to projections which have been little used in this country, together with specimen maps. The latest publication of this sort is a new outline base map of the United States on the Lambert zenithal equal-area projection, scale 1:7,500,000. This is the first map on this projection ever published by the Survey. Besides its useful property of equal area, the projection has smaller scale and direction errors than the polyconic projection map which has been so frequently used for political, census, and miscellaneous statistical purposes.

The Federal Board of Surveys and Maps, created by an executive order of December 30, 1919, is now fully organized, with representatives from 14 map-publishing branches of the Government. At the initial meeting of the Board, in January, officers were elected for 1920, viz., O. C. Merrill, Forest Service, chairman; William Bowie, Coast and Geodetic Survey, vice-chairman; C. H. Birdseye, Geological Survey, secretary. Committees have been appointed on topographic maps, highway maps, hydrographic maps, photographic surveying, and several other special subjects. A Map Information Office has been organized, with headquarters at the U. S. Geological Survey. The establishment of this office is an event of much public interest, as it provides a central agency in Washington from which information can be promptly obtained concerning all map and survey data available in the numerous Government offices which carry on cartographic work of any kind. The new Federal Board is charged with the duties of making recommendation to the several departments of the Government or to the President for the purpose of coördinating the map-making and surveying activities of the Government and of settling all questions at issue between the departments relating to such subjects, within the limitations of existing laws. The Board is also directed to hold meetings at stated intervals, to which representatives of the map-using public shall be invited, for the purpose of conference and advice. These meetings will be held hereafter on the second Tuesday of January, March, May, September and November of each year.

Industrial Efficiency

Japan's Seaweed Pulp Industry.—That the manufacture of paper pulp from seaweed is proving a profitable undertaking seems evidenced by the fact, reported by Consul General George H. Scidmore, that the only company manufacturing this pulp is building another factory. This concern was organized in December, 1919, and is producing, by a secret process, about 50 tons of pulp daily, which is largely used in the composition of cigarette paper. The new plant when completed will have a daily capacity of 150 tons of pulp. The present price is about 5 cents a pound.

New Glass Industry.—Important developments are eventually probable on the northern borders of Dartmoor, in Devonshire, England, in consequence of the discovery of a very large deposit of granulite, a substance of much value in the manufacture of glass. According to experts, "granulite contains not only silica, but potash, soda and alumina, which are necessary in glass making, and its use is not only economical but gives the best results in the production of glassware of the highest quality." It is stated that an experimental furnace has been in use for some time, two others are being constructed, and it is anticipated that the commercial manufacture of glass will commence almost immediately.

Success of German Fairs.—The success achieved at the first International Fair held in Frankfurt last fall has led the city authorities and especially the directors of chambers of commerce in several German cities to study the value of fairs as a medium for bringing together buyers and sellers not only in Germany but from all parts of the world with the object of fostering the intensive reconstruction program now occupying the business men of Germany. The city of Stuttgart leads all German cities in the number of fairs scheduled for 1920. A jewelry fair has just been held and reports have been received that it has been a great success for the exhibitors. Another jewelry fair will be held in September. A medical technical fair was held from April 5 to 18; photographic fair, May 2 to 16, and a book fair was planned for June. Fairs will be held in the following cities: Breslau, Danzig, Frankfurt, Cologne, Königsburg, Leipzig.

Unique British Advertising Plan.—The Federation of British Industries has devised a unique scheme for advertising home manufactures in all parts of the world. A new steamship to be called the "Federation" is to be constructed by some of the leading firms of the country as an exhibit of British marine engineering. The cargo of the ship will consist of various articles of British manufacture. Representatives of the firms interested will make the voyage for the purpose of showing their goods and interviewing foreign buyers. It is believed that a splendid opening will thus be afforded for extending British commerce in foreign countries. The first voyage will probably be made to the various ports of South America, and subsequent voyages will be made to the Mediterranean, Scandinavia, Baltic ports, the Far East, and Australia. Among the exhibits will be airplanes and airplane parts, and there will also be motion picture apparatus on board for the purpose of showing British films.

Germany's Wood Problem.—According to press reports, tremendous sums have been paid in Germany at public sales, not only for the State and community forest products, but also at auctions which took place in private woods. As early as last August the Central Government issued orders to the different State governments that home industries should be first protected in all wood sales. But these Government measures, taken in favor of the general consumer of wooden articles, seems to have had little effect. By selling the wood at a cheaper price to the wood-working industry the State has encountered some loss, notwithstanding which the prices of wood products have increased steadily, as is seen in the constantly rising prices of furniture; the profit remained in the hands of the wood-working industry. In addition to this, a constant export of wood into foreign countries, in spite of the export prohibition, is taking place. In consequence of this, more severe restrictions have been put into force, and it is possible that the wood trade will be licensed for the purpose of putting an end to the wild speculation and profiteering.

Left: 85,000-pound cast-steel speed ring of the Niagara turbine, as it comes from the boring mill. *Center:* Shop view of the assembled spiral casing for the Niagara turbine. *Right:* Solid bronze runner for the Tallassee turbine, the largest casting of the sort ever made.

Some striking parts of the world's greatest turbines

Descendants of the Water-Wheel

Installations for Developing Hydroelectric Power upon a Notable Scale

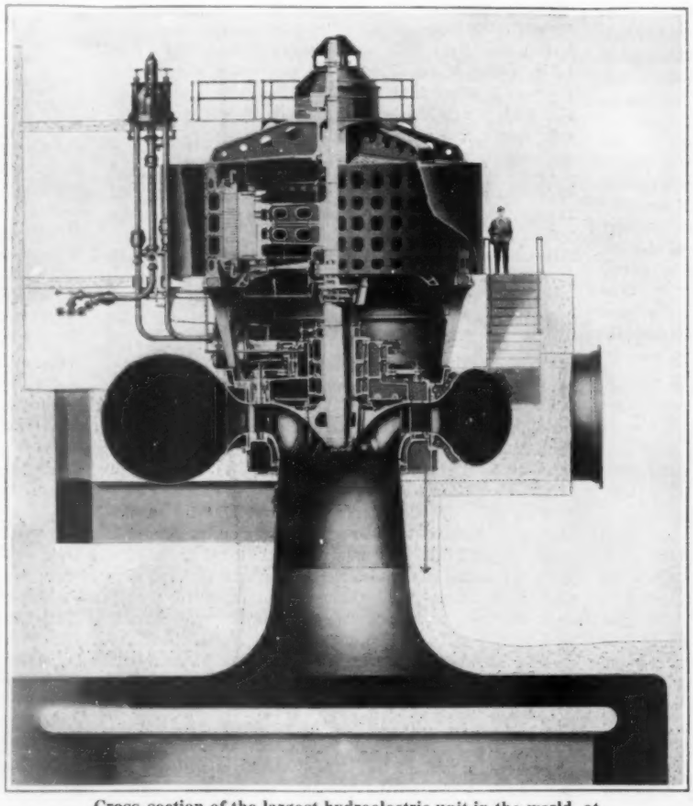
By J. F. Springer

FROM very early times men have sought to utilize the mechanical force exerted by the wind and the waterfall. The undershot water wheel is said to have been the first of the water-power devices, and the breast and overshot wheels are perhaps to be placed next in order. While these apparatus are not to be regarded as efficient in the modern sense, they are by no means obsolete. This is to be explained by the ease and economy with which they may be constructed and installed. It is often a matter of no moment whether there is waste of power water or not. At other times, however, it is of high importance to use the available water power to the greatest possible advantage. In such cases the modern designs must be called into service.

At present modern up-to-date water-power installations belong to one of two types—the Pelton and the Francis wheels. In general, Pelton wheels are mounted on a horizontal shaft; Francis turbines may be mounted upon either a horizontal or a vertical shaft. The Pelton wheel is driven by the force directly imparted by a jet of water. It is classed as an impulse device. In Francis turbines, the drive is effected more or less by reaction.

Notable installations of water turbine units are those at Niagara Falls, N. Y. The development calls for three gigantic units with vertical shafts. These operate big electric generators rotating in horizontal planes. There will be, presumably, three designs of electric generators, since three different concerns are to furnish them. One of these is also to supply the hydraulic unit as well; a fourth concern furnishes the water units for the two other generators. In one of the illustrations is a vertical elevation (partly sectional, partly cut away) showing one of the complete hydroelectric units. This is a vertical unit because the main shaft is vertical. It will be noted that this shaft is in two parts which are bolted together. The lower part belongs to the hydraulic unit and the upper one to the electric generator. Below the shaft is to be seen a great vertical conduit which increases in diameter as it descends. This is the draft tube—the earlier part of it. The spent water passes down and out through the draft tube. The water enters the horizontal water wheel—the runner—from an encircling conduit. This conduit is a very interesting affair. In the present case it consists of a big metal tube of continually diminishing diameter arranged to encircle the runner. Concrete has been the favorite material, but there seems to be some tendency of late to interpose a steel lining between the concrete and the water. The conduit is open pretty much all round its inner circumference. The circular opening is partially occupied by guides which accurately direct the water flowing inwardly from the conduit. The reason the conduit continually diminishes in diameter is that the purpose is to exhaust its supply of water by the time the complete circuit is made. In the figure, this conduit is seen in section at two points, one to the left and the other to the right of the bottom end of the shaft. Other views show the spiral conduit with the guides arranged in its inner circumference; and the framework which holds these guides in place, together with the several guides. The framework with its guide vanes is called a speed ring. In the present case it is of cast steel and has an exterior diameter of 20 feet.

If the reader will now return to the partly sectional view of the whole unit, he may discern the blades of the runner surrounding the bottom of the shaft. This is a tremendously important part of the hydraulic unit, being in fact the water wheel itself. It is secured to the shaft; so that when the water flows into the runner from the enveloping conduit through the openings in the speed ring, not only will the runner be rotated but also the shaft and the attached electric unit. In another view is seen a runner more or less different from the one belonging to the Niagara unit; but the reader will nevertheless understand the general appearance.



Cross-section of the largest hydroelectric unit in the world, at Niagara Falls, N. Y.

The Niagara Falls unit is to have an electric capacity of 32,500 kilowatts. When the water turbine rotates at the speed of 150 rotations per minute and the water has a head of 214 feet, its power capacity is 37,500 horse-power. The size of the whole affair may be judged by comparison with the man standing at the head of the steps on the floor of the generator room. In big units of this kind, it is desirable, not to say necessary, to provide brakes so that the whole apparatus may, upon occasion, be brought to rest. The generator is wound for 12,000 volts. This high voltage is necessary for transmission purposes. The rotating part of the generator—the rotor—naturally rotates at precisely the same speed as the runner; this 150 revolutions per minute is considered quite moderate. However, the enormous electric power is nevertheless produced. The moderate speed made it less difficult to design the rotor. If the runner attains "runaway speed"—that is, about 85 per cent overload—the stresses in the rotor will be not greater than one-third the elastic limit of the material. This means that the stresses will fall far short of effecting permanent deformations. The rotor with its shaft weighs 265,000 pounds. The fly-wheel effect developed by the rotor is 10,500,000 pounds per square foot.

In designing the gigantic unit, it was necessary to bear in mind that all the parts had to be lowered over a cliff to the power house at Niagara Falls. Further, even without this drastic requirement, the limitations of the means of transportation had to be kept in view.

The manner of supporting the rotating parts of a big unit like this is of interest. The rotor, the shaft and the runner are the principal items which go to make up the rotating load. In the present case, the support is near the top of the shaft. By referring to the partly sectional view, the reader may note the thrust bearing floating in oil. The outside diameter is 49 inches and the bearing is said to be capable of supporting 465,000 pounds. There are two guide bearings whose function is not to support weight but to maintain the shaft in exact position. One is located just below the thrust bearing. It is 36 inches long and has a diameter of 22 inches. When the unit is running at 150

(*Continued on page 92*)

Fifteen Thousand Photographs per Second

By F. Honoré

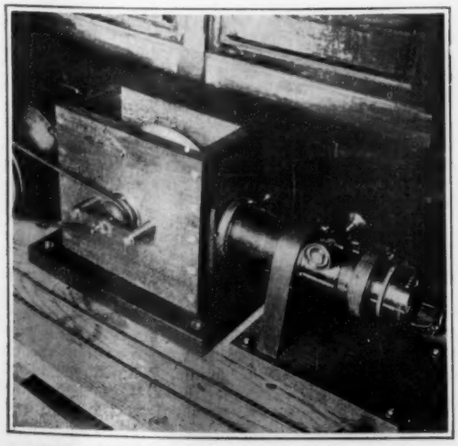
AROUND 1880, shortly after the gelatino-silver bromide plates came into use, a cannon ball in motion was photographed for the first time. The snapshot showed simply a black line representing the trajectory. Later on, an Englishman succeeded in obtaining a picture of the projectile, which was then reckoned as a great achievement. Several years afterwards Professor Marey, desirous of analyzing the flight of pigeons, had a "photographic revolver" constructed, giving twelve snapshots per second. Today, in the same period of time, the ordinary motion picture machine takes from 20 to 250 views. Usually about fifteen are sufficient to obtain the desired impression. By means of special devices combined for scientific researches, M. Bull, Assistant Manager at the Marey Institute, succeeded in attaining a speed of 3,000 views and by using a process invented by M. Abraham, Professor of Physics at the "Ecole Normale," he is able to obtain photographs today at the rate of 15,000 per second. With more highly improved apparatus, he could theoretically obtain 50,000 and even more. These photographs which we are reproducing without any touching-up were recently presented to the Academy of Sciences. They show the successive positions of a revolver bullet and a 37-millimeter shell on part of their trajectory. We are showing below the manner in which M. Bull obtained this surprising result.

Such a quick photographic impression requires a considerable luminous power. On the other hand, it is impossible to imagine a shutter opening and closing 15,000 times during a second. It is therefore necessary to operate without shutter and use a source of artificial light which appears and disappears automatically in order to give intervals of darkness to replace the closing of the shutter. This source of light is given us by the electric spark of a condenser, a spark similar to the one which produces the Hertzian waves. The condenser may be loaded by means of storage batteries. The tension and frequency of the sparks may be adjusted as desired. With a tension of 10,000 volts and a frequency of from 10 to 15,000 sparks per second, the spark is about one millimeter long. If a film is revolving in a continuous movement in front of the electric source, this film will therefore be impressed 15,000 times per second by a spark. On the other hand, each spark lasting only a few millionths part of a second, the film, regardless of its speed, can be considered as being fixed during each pose and consequently the photograph will be very clear.

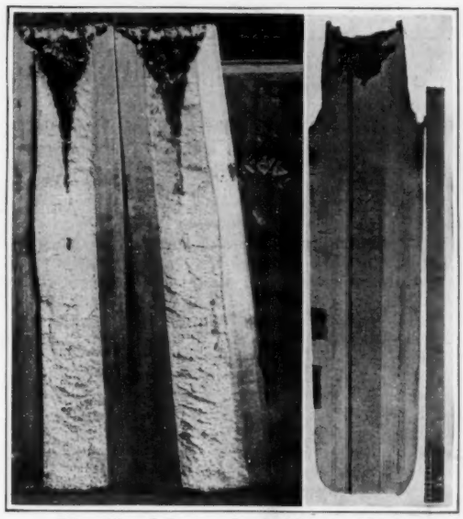
M. Bull makes the spark burst in the focus of a concave mirror of about 40 centimeters in diameter which reflects a parallel pencil of luminous rays which is crossed by the projectile. The latter shows a black silhouette (shadow) on the lighted background at the same intervals as those separating two successive sparks. In front of the point it must pass and at the same distance as the mirror a lens concentrates the luminous rays on the objective.

It is now necessary to receive the pictures on the film with a speed corresponding to that of the succession of sparks. The film, which is one meter long, is wound around a cylinder of the same circumference which moves on a horizontal axis and to which an electric motor gives a speed of 3,000 revolutions per minute, or 50 meters per second. The film makes therefore one revolution in 1/50th of a second. If 100 pic-

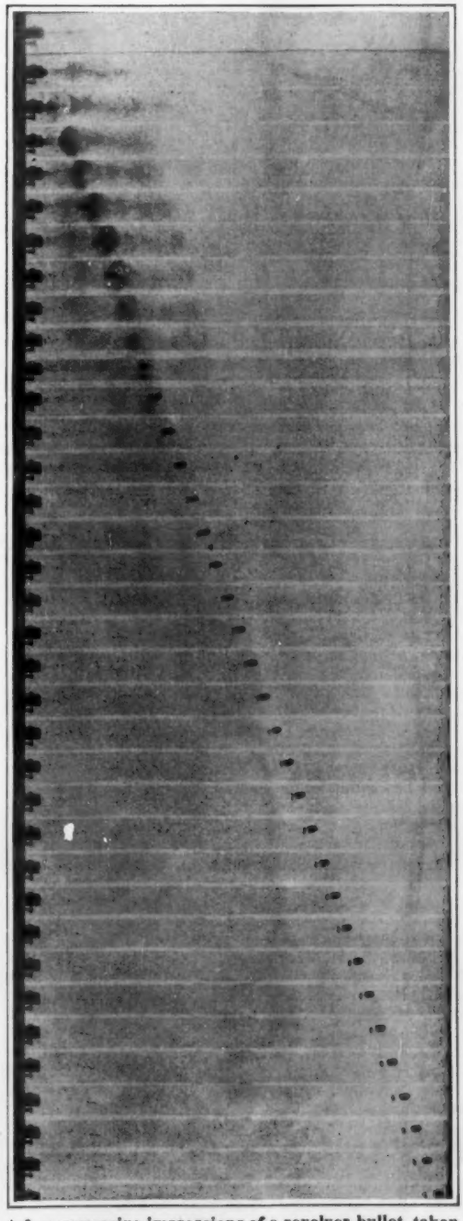
(Continued on page 94)



Close view of the apparatus for rotating the film and controlling the spark



The old and the new in steel ingot-making



A few successive impressions of a revolver bullet, taken at an exposure rate of 15,000 per second

Better Steel Ingots with Less Waste

By A. R. Surface

IMPROVEMENTS in the casting of steel into ingots are being constantly made but there are still many steel mills which adhere to the old practices. According to the old and long established practice it has been the custom and still is where it is used, to pour the molten steel into iron ingot-molds which are smaller at the top than they are at the bottom.

All steel, unless made direct into castings, is poured into some kind of an iron mold in which it solidifies before being further treated or manipulated. When poured into the old style iron molds, smaller at the top than they are at the bottom, they have the shape similar to the left-hand illustration, which shows such a steel ingot split in two, the original ingot being rectangular in shape. It is seen from this that there is a decided area of hollow or spongy steel extending well down into the ingot, nearly one-third down in fact. This portion of any ingot thus poured is worthless so far as further use for rolling or forging into finished products is concerned. It has to be removed, leaving only a portion of the original ingot available for further manipulation in the rolling mill. The amount of waste in a large steel mill where hundreds of these ingots are poured daily is very large. The discarded portion can only be used for remelting.

Realizing the waste involved and the advantage possible if this could be overcome, several metallurgists have devised ingot molds to overcome this. The product of one of the most successful is shown by the other illustration at the right. This is the half of a steel ingot cast in an iron ingot-mold which is larger at the top than it is at the bottom and which uses on the top, when the steel is poured, what is called a "hot top" or sink-head—that is, the top of the iron mold is surrounded with a refractory substance which really builds up or extends the mold a few inches higher. After the steel has solidified in this, the refractory portion is broken away, leaving a protrusion on the end of the ingot.

The advantage of this practise can be readily and quickly seen. Instead of the large hollow spongy portion, called a pipe, which is so evident in the other case, there is in this case only a small hole or pipe which is confined to the extreme upper portion of the ingot and does not extend down into the actual ingot at all. It is plain that the amount of rejected steel in this case is relatively small and also that the quality of steel is considerably better.

It is stated that as approximately 3,000 tons of steel ingots are now produced daily in the United States in these improved molds, the average daily saving by means of this and other patented inventions of this nature is approximately $10,000 and perhaps much more.

Chemical Warfare Service School

CHEMISTS generally have been gratified to learn that steps are being taken to establish a school where men may be trained for the Chemical Warfare Service and where recruits can be given the sort of training which will be very serviceable to them in peace times. Men who are without sufficient resources to gain a technical education can in this way gain the training which will be useful to them in war or peace. From the standpoint of chemical industry, such men would be found suitable as foremen and possibly superintendents in chemical plants.

General arrangement of the camera and appurtenances for 15,000 exposures per second of a moving projectile

Lubricating the World

Some Facts That Show Why We Are Short of Lubricating Oil, and a Few Suggested Remedies

By Eben Griffiths

THE world today is facing a shortage of all petroleum products. We have heard much of this shortage as affecting fuel oils, gasoline, etc., which today form an important part of the world's fuel. Another important phase of the problem is that of lubricating oil. This is the Mechanical Age. Power production has developed throughout the world to a remarkable state of efficiency. Power production demands lubrication, and we know that lubricating oil, like practically every other commodity, is selling today at prices far above what we used to consider the normal range.

What are the reasons for the present scarcity and high price? Is there a remedy in sight? These are the questions that are uppermost in the mind of every man who is using lubricating oil, whether on his automobile, his tractor, or on power machinery.

Where the Demand Comes From

The answer to the first question will be found in the old-fashioned law of supply and demand. Lubricating oil is scarce and high because more people are trying to buy it than can be accommodated without severe strain on the available supply. Such a condition must result in scarcity and a high selling price.

The present tremendous demand for lubricating oil comes from two sources: First, there is a big demand for American lubricating oil in foreign countries; second, there is increased industrial and automotive development in the United States.

During the war producers of lubricating oil looked forward to peace as meaning a lessening in the demand for lubricating oil abroad. It has not worked out that way; for whereas, during 1918, the total exports of lubricating oil were 257,317,253 gallons, in 1919, when a decrease was expected, exports jumped to 277,591,158 gallons. That condition is typical of what has happened in most lines since the armistice was signed. The demand for lubricating oil and other products for reconstruction and industrial purposes under peace conditions, has been greater than the demands for war purposes.

The same thing has happened at home. Although industry was straining every nerve during the war to produce war materials, there has apparently been no decrease in production since peace was declared. While certain industries have slowed down, others have come forward at a rapid rate, with the net results that today the domestic demand for lubricating oil is greater than it has ever been before. So much for the conditions governing demand. Now let us turn for a moment to the consideration of the sources of supply.

The Oil Supply

First of all, in considering our present supply we have to remember that when peace was declared, the oil industry had been straining every nerve to supply petroleum products for carrying on the war. Reserve stocks had been exhausted and we entered the peace period practically on a "hand-to-mouth" basis, so far as available oil stocks were concerned.

In the meantime, foreign sources of supply had been shut off. Russian crude oil is for all practical purposes, not available. The same is true of the Galician and Roumanian fields. The United States is today supplying the great bulk of lubricating oil used by the world.

On the other hand, production had been speeded up somewhat by war demands. New fields had been exploited. New wells had been opened up. But the increased supply was not equal to the increased demand. The result has been that today the better grades of crude oils are comparatively scarce. It naturally follows that they are high in price.

Four or five years ago, Pennsylvania crude oil sold for $1.35 a barrel. Today it is quoted at more than $6 a barrel, and it is usually necessary to pay a premium on top of the listed price to secure crude oil in any large quantity. Other crude oils have advanced in the same way. And the end is not in sight.

This, then, is a picture of conditions as they are today: A tremendously increased demand for lubricating oil at home and abroad finds reserve stocks exhausted, foreign oil fields out of the market, and production in the United States increased but not enough to take care of the increased demand.

The Remedies

What are the remedies for the present situation?

First of all, we have the natural law which tends to harmonize supply and demand. High prices in themselves are a deterrent to use. We can safely count on some readjustment from this factor.

Much depends upon the foreign situation as regards credits and exchange. As credits to foreign countries are cut down it will naturally follow that less oil will be bought for export. It is also reasonable to assume that foreign production will soon become an important factor again. But the big remedy lies in an increased activity on the part of American capital in developing oil resources at home and abroad.

Much has been written about the threat to America's leadership in the oil industry. It has been said that England and other countries are endeavoring to usurp America's place as the leader in oil production. Of course, this is mere speculation, and looks far into the future in an effort to predict possibilities and not probabilities.

Few of us realize how great is America's leadership today in the production of oil. The United States today is producing about 70 per cent of the world's supply of petroleum. About 16 per cent is coming from Mexico, and about half of this Mexican supply is being produced by American capital. The other 14 per cent is coming from Central and South America, Russia, Roumania, Galicia and other spots of the world's domains. In 1916, the marketed production of petroleum products of the United States was 301,000,000 barrels; in 1917, 335,000,000; in 1918, 356,000,000. The United States Geological Survey estimates our unproduced but recoverable oil in January, 1919, as 6,740,000,000 barrels.

THE acute character of the petroleum situation is, as yet, apparent to the general public only in the elevated price of gasoline, and in the occasional difficulty in buying this fuel at any price. We have touched upon several aspects of this in recent issues; but gasoline, as we have already pointed out, is only one of the petroleum derivatives. Just to what extent the shortage is felt in other directions, how serious the situation is outside the matter of gasoline, and what remedies may be looked for, are topics of importance second only to that of gasoline. So far as they relate to the field of lubricating oil, they are discussed in this article by a man who is thoroughly familiar with that field.—THE EDITOR.

While the above does not indicate that the United States is in danger of being surpassed as a producer of petroleum, it is a fact that this country must be alert to the situation, and must not sit idle while other countries develop their resources.

America's opportunities are: To conserve and to develop the vast oil resources that still remain in this country; to enter whole-heartedly into the development of oil lands in foreign countries, especially in Mexico, Central America and South America; to discover the most practical and economical way of developing the shale oil deposits that lie in vast quantities in the Rocky Mountain states; and to urge and promote economy and efficiency in the handling and use of petroleum products.

Oil Waste

This matter of the economical use of our oil supply is one of vast importance, not only to the country as a whole, but to each individual user of lubricating oil. Much of this waste occurs in the oil fields. Unlimited supplies in the past have brought about wasteful methods of recovering and storing oil. Vast quantities of oil run to waste every year in the oil fields. Oil men are today keenly alive to the situation, and able brains are devising ways of eliminating this waste.

But the waste which comes closer to most of us is that in the use of petroleum products. In lubricating oil alone, large quantities are wasted every year through unintelligent use. In almost every industrial plant more lubricating oil is used than is necessary to secure efficient lubrication. Oil is bought in quantities, and the application is usually in the hands of someone who is not especially interested in operating economy. He is interested, however, in "avoiding trouble," and his own idea of how best to avoid trouble is to "pour on plenty of oil." In that belief, lies one of the greatest fallacies in the world. "Plenty of oil" does not necessarily mean good lubrication. Correct lubrication consists of applying the right oil in the right places in the right way.

There are certain definite rules by which every user may help to eliminate waste in lubricating oil whether he is operating an automobile, a tractor, or an industrial plant. Perhaps the most important of all is to buy the correct oil for the purpose for which it is intended. This may sound like an academic statement, but it is strictly a matter of dollars and cents and oil conservation. We will all agree that no one oil will lubricate all types of machinery. We wouldn't use the same oil in a steam cylinder as we would on the shafting. We wouldn't use the same oil in our automobile engine as we would in the rear axle. But the difference does not stop there. For practically every lubricating need in any machinery, there is a correct oil, and there are hundreds of incorrect oils. If we use the correct oil, in nine cases out of ten we will use less of that oil than we would of an incorrect oil. In addition to that, there are resulting advantages in reduced friction, increased power, etc., which we need not go into here.

A second fundamental point is to use only high quality oils. In lubrication, perhaps as much as anywhere else, it is axiomatic that quality means true economy in the long run. High quality oils may cost more by the gallon, but they will cost less by the year, and we will be helping to eliminate waste of oil by using less gallonage.

Third, it is essential to install mechanical lubricating devices on machinery. We have already spoken of the fallacy that the more oil we put on the better lubrication we secure. One drop of oil at regular intervals will provide better lubrication than a lot of oil poured on at irregular intervals. For practically every lubricating requirement in every plant, there is available on the market a mechanical lubricating device which will supply regular and constant lubrication to the frictional surfaces without danger of too little lubrication and with the absolute elimination of waste in applying the oil.

Finally, we must prevent leakage from barrels or packages. A great deal of oil runs to waste every day in garages and in plants through careless handling and improper storing of barrels and packages. A leak of one small drop of lubricating oil per second from the faucet of a barrel means a loss of 34 gallons in a month.

The above suggestions are typical of many that might be made for the conservation of lubricating oil. It is essential that the American people practise this conservation in order to help bring about a return to a normal basis. Oil interests today are actively at work on remedies for the present situation. In order that they may have time to work out this problem properly, economy in the use of our present supplies is most important.

The Detachable Broom Handle

THIS is the day of high-living costs—but it is also the day of new and crafty ways of sidestepping the onslaughts of the ugly ogre. The latest device to enlist on the side of the people is the detachable broom handle.

At first thought the broom handle seems inconsequential. Isolated and individually it is. Multiply it by some fifty millions or more, which probably approximates the number of brooms sold yearly in the United States, and you have something quite different.

The detachable broom handle is a brand new idea and it is taking. At the present time there is a factory in Vermont devoted exclusively to manufacturing brooms with this type of handle. The handle is of wood fitted into a metal holder that clamps easily on to the brush of the broom. The metal part is light, but very strong, being securely welded by the oxy-acetylene process, which not only makes it rigid but allows the entire piece to be neatly finished.

Some Observations on Eggs

Scientific Principles That Enter Where Least Expected and Are Carried Out Unrecognized

By John T. Bartlett

APPLIED science enters into the daily life of the city dweller at every turn; but the city dweller never has to worry about it. His applied science is atended to for him by somebody else, and comes to him in neat packages so that all he has to do is to turn a switch or lift a finger. But the farmer lives in smaller communities, much closer to nature; and while vast achievements have been recorded that go to make his life less isolated and less laborious, the general statement may still be made with a good deal of confidence that he must for the most part attend to his own applied science. He even has to go further than that in a good many cases and lay his own foundation of observational and experimental work—he may not realize that he is laying scientific foundations for future use at the moment, but that is what it really comes to. There are many illustrations that might be adduced to show that all this is so, but no space in which to adduce them all is available. A couple of the more striking will have to suffice and it happens to be convenient to take them from the same department of farming.

Take the matter of getting to market with the fragile hen-fruit. Scientists and inventors galore have worked on this problem, as the records of the patent office will demonstrate. Yet even before them, the farmer himself had learned that eggs may be driven to town without loss if they are packed in oats. The handy firkin is the rough-and-ready container, and packing is at hand in the feed room.

No matter how rutty, rocky and crooked the road to be traversed is, the contents are safe in this humble berth. The oats absorb the violent joltings and swayings. The eggs are traded in at the store without so much as a small crack. The packing is carried home and fed out. Then the storekeeper, having resort to an invention of comparatively recent years, the American egg case, opens carboard "fillers" and packs his fragile purchase for shipment to the large city market, where the eggs are either distributed for immediate consumption or placed in cold storage.

We in the United States are given to invention, and our egg case with its paper fillers is characteristic. Canadians are much like us. They use the same case we do. But because traffic in eggs thus packed reaches enormous annual proportions, we must not presume that this method is the only one followed or even the only quite practical one. It is not a perfect method, either. In fact, what the ultimate universal method of egg-packing will be, nobody knows, though naturally we Americans believe it will be of our development and in the direction already indicated.

It is entirely possible to use in a wholesale way, shipping long distances, the packing method which American farm-wives still use in carrying eggs to the village store. Chinese districts, for example, utilize two compartment cases in which oil cans have been shipped, and the packing material is hulls which act much as do oats. The Chinese second use of a commercial package is also paralleled in this country, where flour barrels are commonly used for apples and sacks for various products over and over again.

There was recently held in London an egg-and-poultry conference at which egg-packing methods were a foremost topic. We know our American method is not perfect, of course, but we are wedded to it. Its principal weakness is the fact that while eggs are not arbitrarily sized, the cardboard compartments must be. When eggs were much cheaper than now, this disadvantage was not of much consequence. The occasional breakage resulting when an egg was too large for the standard compartment did not matter much. A careful Yankee poultrykeeper shipping hatching-eggs in cardboard compartment containers is sure to wrap each egg loosely in newspaper fragments. There is an opportunity for some ambitious inventor to perfect our egg-packing materials, never losing sight of those important considerations, light weight and convenience. In rapidity of handling no method is the equal of ours.

The Danish way is to pack eggs in wood wool, the name given to a very fine kind of excelsior. The Danes are satisfied with their method. The bulky case in which they ship is so heavy that several men together must handle it. The Danish poultrymen find this works in their favor, preventing the careless, rough treatment, resulting in breakage, to which the Irish and American cases, both one-man affairs, are subject.

The writer has no data on the point, but it is a reasonable assumption that the capacity of the American case—thirty dozen— was determined in the beginning by the consideration which, in one respect, now works against it—a sensible size for the average man to handle unaided.

The Irish use still another packing method. They ship eggs between layers of straw. These layers are substantial, and if the packing is conscientious and after-handling reasonably careful, the eggs arrive at their destination with every individual specimen in good order.

While on the subject of eggs, it might not be out of order to point out that the big laying capacities which hens develop nowadays are also the result of more or less scientific investigation, of much the same impromptu sort that the farmer has given to the transportability of the eggs after their production. There is indeed a scientific principle involved in the unnatural stimulation of the egg-producing organs, which is often lost sight of, but which the farmer knows a good deal about, from his observations on domestic and wild fowl alike. For the domestic chicken was originally wild, and if we study the wild birds carefully we see the same principle, the mere existence of which has eluded the notice of most persons.

Take a recent case on a Western irrigated farm, where a meadow lark's nest, concealed in an alfalfa

(Continued on page 94)

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

First Consideration for the New York State Barge Canal

To the Editor of the SCIENTIFIC AMERICAN:

I am interested in the article in your issue of June 19th, regarding a greater ship canal via the St. Lawrence to the sea, which to a novice may appear as an easy financial problem, because of the great sums of money which were so quickly raised for war emergency. I agree with you that our efforts should be expanded on the New York State Barge Canal, which is now in operation. Its promoters are now struggling with the State Finance Department to get a little more money to complete the general plan which includes the erection of terminal elevators. This will thoroughly relieve the East and West traffic between the Great Lakes and the sea.

I am a close student of this question of Lake-to-the-Sea Canals, and have an intimate knowledge of both routes. My fifty years of shipbuilding and maritime experience includes the building of more than 150 steel ships and the operating of many of them on rivers, canals, the Great Lakes and the ocean, and of some of them around the world. Before the Lower Canals were built, I personally built and took three large steel ships through the St. Lawrence Rapids to the sea; and some of these same ships, with others, I cut in two and brought back again to the Lakes. Before the Lower St. Lawrence Canals were finished, I ran the Rapids of the St. Lawrence in these interests more than twenty times. I personally sounded the shoal spots of the channel, except in the rapids, from Lake Ontario to Montreal. I have been called upon as expert witness by the Canadian Privy Council to give evidence relative to this outlet to the sea.

Just before the war I came from Liverpool to Montreal in order to study the gulf and inlet from the sea by use of ship's charts, and was given the privilege of viewing the river from an elevated position on board. The gulf is noted for its high tides and for the snow and fog in spring and fall, making it dangerous navigation. A ship wrecker of my acquaintance had twenty-two ship wrecks to salvage there in 1919. Notwithstanding this, doubtless there may some day be a large ship canal there, and also the original water route via the Ottawa River and Lake Nipissing between Montreal and Lake Huron. This route was intensively operated between Montreal and the Northwest from 1730 to 1830, and the success of the New York Canal may some day call for this as an outlet for ships.

For the past few years I have made trips along the construction of the New York Barge Canal, and have just returned from there. I have seen every lock in the main canal in operation. The slowest or deepest lock on the canal is at Little Falls, where I saw a tug and barge locked through in less than twenty minutes, without special effort. A large ship would take less time. I think ships could satisfactorily use the canal that measured 300 x 43 x 24 feet; that would carry about 5,000 net tons on the Lakes and coast, and through the canal about 4,000 cubic tons, or as much as 116 full-size box cars. When the state has granted a little more money to finish up the work, making passing stations on long levels, so that the large ships can pass each other, it may be possible to pass in one direction twenty million cubic tons of cargo in 220 days of the year. The effect of this on the cereal crop of the Great Lakes basin will amount to more than twenty million dollars per year at one cent per bushel. The amount of package freight from manufacturing companies will also be a large tonnage for Eastern consumption and export.

The building of the St. Lawrence Canal, as advocated by its boomers, would cost more than to build a larger canal from Oswego to Albany and New York, the route for which, including a connecting link from Lake Ontario to Lake Erie, has already been surveyed by our government engineers. The Welland Canal, to cost about seventy-five million dollars, is only about 25 per cent done, and will take many years to finish. When done, it will make a splendid outlet for both Canadian and United States tonnage via Oswego through the Barge Canal to New York.

Because of hostile propaganda against the Barge Canal the public has a wrong impression of this fine, useful, free waterway to the sea. An eminent engineer, who did much of the designing and planning of the Panama Canal and also of the New York Canal, tells me that the New York Canal is the greater of the two in work and skill. It is now in operation, and in one or more years will have 5,000-ton ships passing through that can trade to all parts of the world. When in smooth running order I think it will have more Canadian Lake ships pass through it than to Montreal, the Lake ships on both sides collecting cargoes at Lake ports for Eastern consumption and export, and returning with all kinds of imports. They will also bring U. S. coal from Utica and Watkins, the canals on both side being free for both U. S. and Canadian ships.

I think those who are agitating the St. Lawrence outlet have not fully considered the enormous opposition to it from the many trunk line railroads that parallel that waterway in both the United States and Canada. They have forgotten, also, the transfer points at the terminals: Port Colburn, Kingston, Montreal, Quebec, Halifax, St. John, Portland, Boston, New York, Philadelphia, Baltimore, Norfolk, etc. They should consider the Southern and Western States and provinces, which will be indifferent to, or against, the St. Lawrence project, at least until the *New York Ship Canal*, as it should be called, shall have demonstrated its value.

ALEXANDER MCDOUGALL.

Duluth, Minn.

The Cruiser Courageous

To the Editor of the SCIENTIFIC AMERICAN:

In glancing through some back numbers of the SCIENTIFIC AMERICAN I found in the number dated December 21st, 1918, a picture of a two-funneled cruiser fitted as an airplane carrier described as the "Courageous." The SCIENTIFIC AMERICAN for June 21st, 1919, however, prints plans and profiles of various British ships which show the "Courageous" with only one funnel and the light cruiser "Raleigh" with two very like those of the aircraft carrier previously illustrated; so it seems certain that the so-called "Courageous," with two funnels, is really the new "Vindictive," originally named "Cavendish."

R. H. FITZ-HERBERT.

Havelock N. Hawke's Bay, New Zealand.

Cutter Versus Sloop

The Past Thirty-Five Years of Racing for the America's Cup

WITH each successive series of races for the America's Cup the SCIENTIFIC AMERICAN has published a set of diagrams of the contending yachts; and this year the presentation is brought up to date by the addition of the profiles and midship sections of the challenger and defender of 1920. The period from 1885 onward is the most interesting for the reason that the "Puritan" was the first defending yacht built specially to meet the challenger, and from the time of the "Thistle" onward all the British yachts have been built with a special view to "capturing" the Cup. Previous to 1885, the majority of the challenging and defending yachts were schooners. From 1885 to 1920 all of the boats, both British and American, have been single-stickers.

The "Genesta" (1885), the fastest of the British cutters of her day, was a thoroughly representative yacht. Because of a British rule of measurement which put a heavy tax upon beam, the British cutters were very narrow in proportion to their length and depth. They were heavily ballasted with lead, and they carried only a moderate amount of sail for their large displacement. The "Puritan," a typical American sloop, by Burgess of Boston, was a yacht of great beam, shallow draft and small displacement, carrying a large sail spread in comparison to her displacement. Thus, the "Genesta" spread 7,141 square feet on a displacement of 141 tons; whereas the "Puritan" of only 105½ tons carried 7,370 square feet. Apart from her great beam and shallow draft, the sloop was equipped with that distinctively American contrivance, the centerboard, which, in sailing against the wind, was lowered in order to give sufficient lateral plane to keep the yacht from making leeway.

The "Galatea" (1886), a big, heavily-built cruising cutter, should never have been sent over for the Cup. She had won but a few races on the other side, and although a very handsome cruiser, she had neither the handiness nor speed that would warrant her being matched against the fleet American sloops. "Mayflower" was designed by Burgess especially to meet her. She had a foot more beam and about a foot more draft than "Puritan," and on a displacement of 110½ tons she spread 8,800 square feet of sail as compared with 7,387 square feet of sail for the "Galatea," whose displacement was over 157 tons.

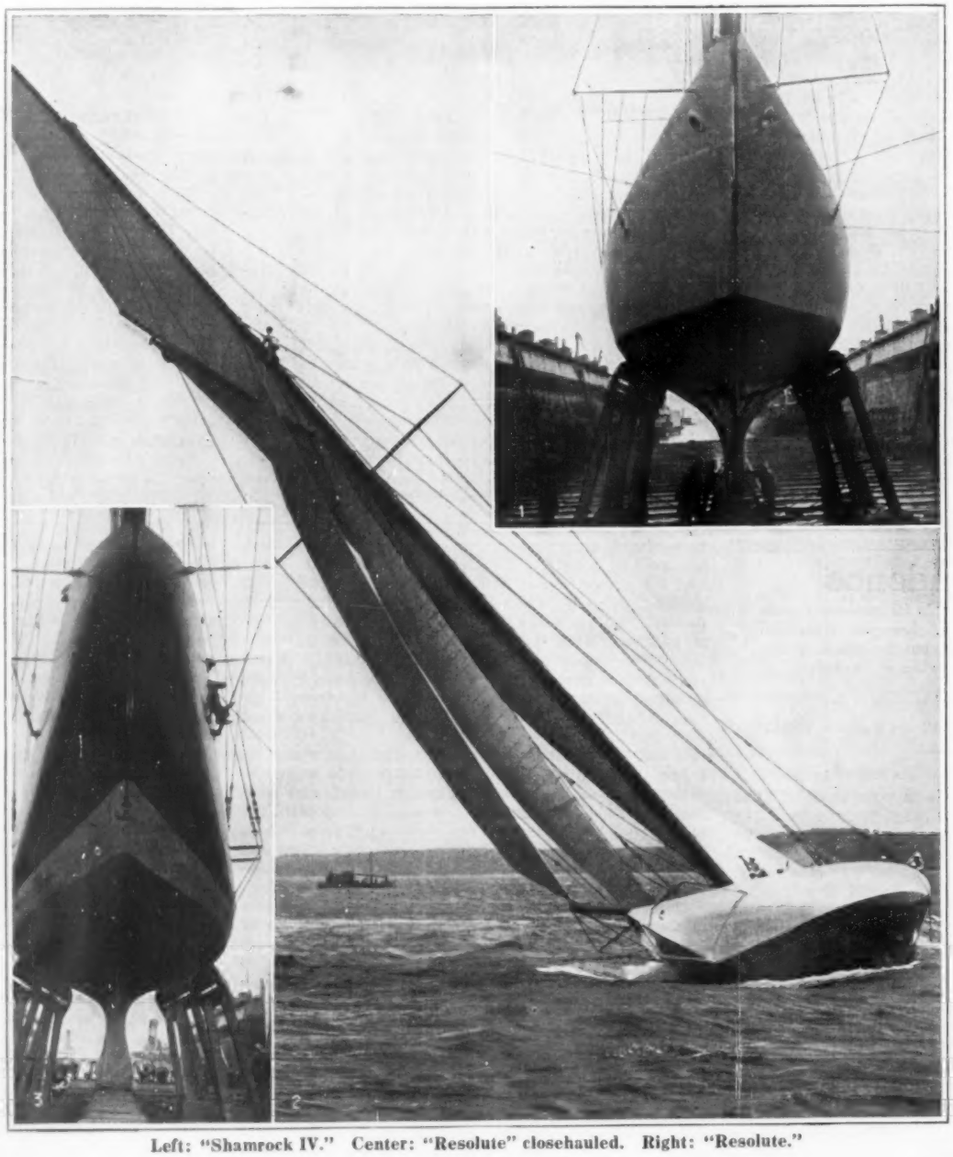
At this time the British abandoned their former rule of measurement and substituted one based upon length and sail area. With the tax upon beam removed, Mr. Watson designed the "Thistle" of 138 tons. The value of beam for sail-carrying was shown in the fact that the sail area went up from 7,387 feet in "Galatea" to 8,968 feet in "Thistle." Burgess, of Boston, designer of the "Puritan" and "Mayflower," brought out the "Volunteer," a sloop of 134 tons' displacement and spreading 9,271 square feet of sail. As compared with "Mayflower," the beam was decreased four inches and there was a slight increase in the draft. It should be noted that the "Volunteer" was built of steel. In all three series of races the American sloop proved to be more than a match for the British cutter, whose lateral plane was so greatly cut away that she could not point with the American boat.

Between 1887 and 1893, Watson had designed for the Prince of Wales, afterward King Edward VII, a very successful cutter, the "Britannia," which swept the boards in all the European races; and for the challenger of 1893, he designed "Valkyrie II," which was of the "Britannia" type. By the "Britannia" type we mean a cutter in which the lines are carried well out into the overhangings and all superfluous deadwood is cut away. "Valkyrie II" of 148 tons' displacement spread 10,042 square feet of sail. She had over two feet more beam than "Thistle," or 22½ feet; and her draft was between three and four feet greater. To meet her, Herreshoff designed the "Vigilant," a sloop with the enormous beam of 26 feet, four feet less draft than "Valkyrie II," and with 1,300 square feet more sail. Like all her predecessors, she was a centerboard sloop. In this series of 1893 the British began for the first time to show a speed that compared favorably with our American sloops. In the third race to windward and leeward, "Valkyrie II" beat the "Vigilant" to windward, but lost by 40 seconds on the run home because in the strong wind two of her spinnakers were blown away. The following year, "Vigilant" was taken over to race in English waters, and was frequently beaten by "Britannia." Hence it is not surprising that in the series of races of 1895 Herreshoff should have dropped the centerboard and built a yacht which in its profile and cross section approximated the new and very successful "Britannia" and "Valkyrie" type. His change from centerboard sloop to keel cutter was a logical development from his success in the smaller classes with "Gloriana" and "Wasp," which anticipated many of the features which characterized the "Valkyrie" and "Defender."

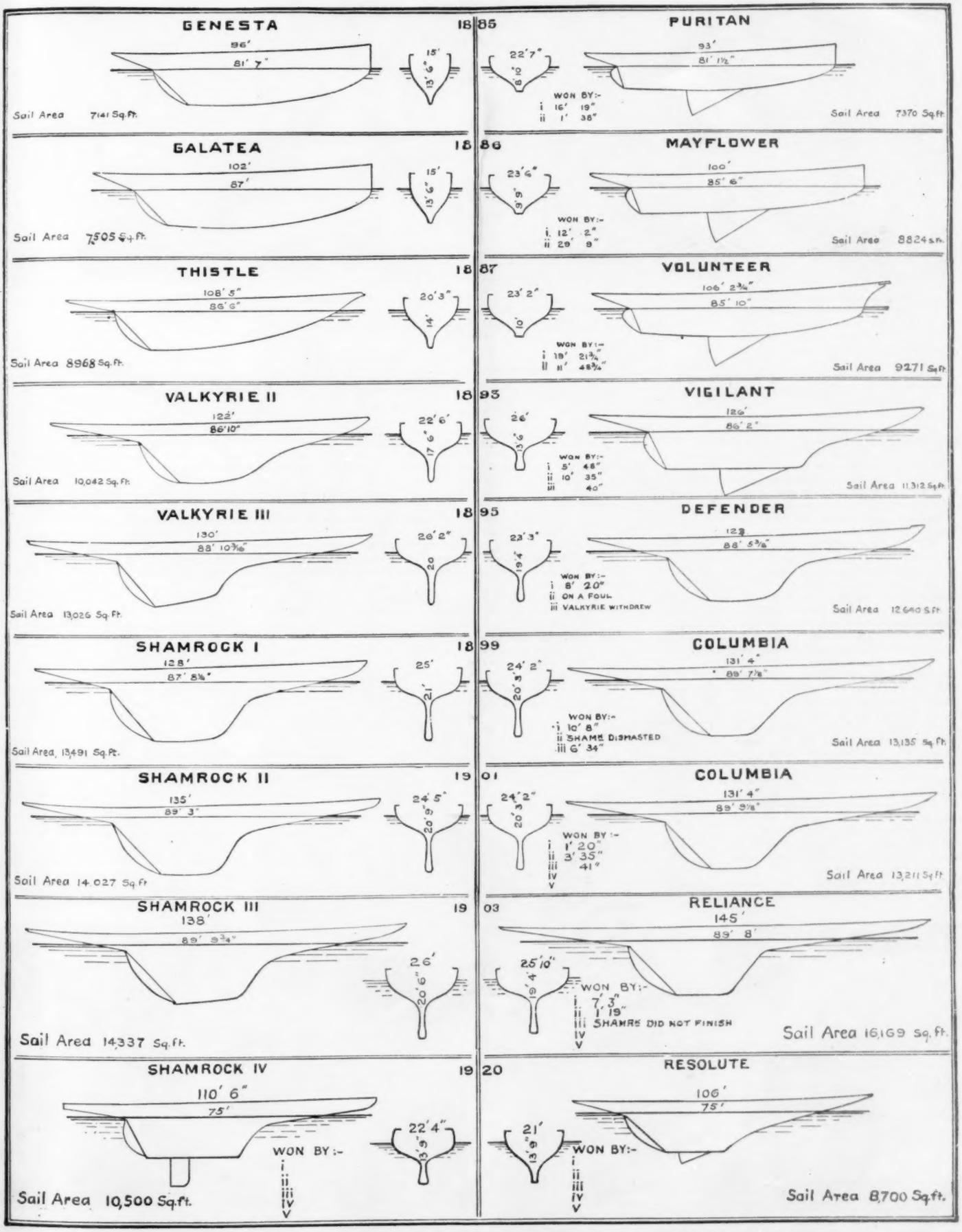
Just as Herreshoff was influenced by "Valkyrie" in designing the "Defender," so was Watson influenced by "Vigilant"; for "Valkyrie III" had the great beam of 26 feet 2 inches, or slightly more than that of "Vigilant." She had something of the full bilges and shallow hull of the American sloop, and on a displacement of 155 tons, spread 13,026 square feet of sail. "Defender" was built with a bronze underbody and aluminum-alloy topsides. She was a remarkably light boat in construction and weight, and on a displacement of 143 tons, she spread 12,640 square feet of sail.

For the races of 1899, Fife, a designer of scarcely less distinction than Watson, was selected to design "Shamrock I"; and to meet her Herreshoff turned out the "Columbia," probably his most successful yacht. In the next series of 1901, Watson was called in to design "Shamrock II" and the wonderful "Columbia," proving better than Herreshoff's new "Constitution," was selected once more for the defense of the Cup. "Shamrock II" proved to be by far the best boat sent to this side, as is proved by the small margins by which she lost the 1901 series. It is the opinion of many American yachtsmen that her failure to take the Cup was due to poor handling in the races. In 1903 Fife was called in again, and he turned out one of his characteristically beautiful boats with a very sweetly turned and admirably proportioned hull—a powerful craft spreading 14,337 square feet of sail. To meet her Herreshoff, influenced no doubt by the great speed shown by "Independence" with her scow-shaped hull, built a most extreme boat, the "Reliance," which on a waterline length of 89 feet 8 inches showed a total length of deck of 145 feet, and spread the enormous area of 16,160 square feet of sail. "Shamrock III" made a good fight for the Cup.

For the 1920 series, it was agreed that, for the sake of economy and all-round convenience, the length of challengers and defenders should be restricted to 75 feet on the waterline. The two boats are built under a rule which aims to prevent such extreme racing craft as "Reliance" and "Shamrock III." A premium is put upon displacement, and a heavy tax upon the sail and upon shallow-bodied, full-ended boats of the "Reliance" type. Herreshoff, in "Resolute," has turned out a small boat that aims to get every advantage possible from the rule. Nicholson, on the other hand, has accepted the penalties of the rule, particularly as regards sail area, of which his "Shamrock IV" carries about 20 per cent more than the defender, "Resolute."



Left: "Shamrock IV." Center: "Resolute" closehauled. Right: "Resolute."



DEVELOPMENT OF CHALLENGERS AND DEFENDERS OF AMERICA'S CUP FROM 1885 TO 1920

Left: Placing in the molds the hot syrup used in the manufacture of hard candies. Making hard candies is merely a miniature reproduction of ordinary foundry practice. *Center:* Slabs on which color and flavor are added to the fondant filling for chocolates. *Right:* The Jordan almond machine, where the nuts get their coating of hard sugar.

Making sweets for the biggest candy-consumer among the world's nations

Uncle Samuel's Sweet Tooth

Manufacturing Candy on a Huge Scale to Meet the Demands of the American People

By H. A. Mount

WE haven't the statistics, but we will venture the statement that if all the candy the average American girl eats in a year were placed end to end, it would reach the enormous distance of nearly half way around her appetite. But we can't blame it all on the boys and girls. Every member of the family has a hand in it and the total amount of candy consumed in the United States reaches the proportion of hundreds of tons a day. We are the greatest nation of candy eaters on earth and it has been said that all of the rest of the world combined eats less candy than we do. Our appetite for sweets supports a large industry, but it is not the purpose here to deluge you with facts, rather to show how this great quantity of candy is produced.

Like most of our modern industries candy-making has been greatly affected in recent years by the introduction of labor-saving methods and modern machinery. The most expensive candies, those which retail at two dollars a pound and upwards, are still made almost entirely by hand. They are cooked in small batches and in general follow the same sort of technique that sister uses in making fudge on the kitchen range. The output, it is true, may reach several tons a day, but this is accomplished by the addition of workers.

The next grade of candies, those retailing at from a dollar to two dollars a pound are also cooked in small batches, usually in kettles of about fifty pounds capacity. It is claimed by the makers that greater uniformity and better flavoring are thus secured. If a kettle full of candy is spoiled in the making it can be thrown away without much loss, whereas if larger quantities are made, the candy has to be "doctored up" and passed on to the consumer, who never suspects the trick.

In making the cheaper grades of candies, the bulk chocolates and the "hard tack" of school days, great kettles of as much as a thousand pounds capacity are used and machinery largely replaces hand labor in the production process.

Most candy manufacturers buy their chocolate in fifty pound bars from chocolate manufacturers. But some of the makers of fine candies buy the cocoa bean, roast and grind it, and add their own ingredients. It adds to the cost of the candy to make the chocolate in such small quantities, but the blend is "just right."

As the quality of candy goes up the proportion of nuts and fruits used increases. One manufacturer of an expensive brand of candy uses 35,000 pounds of nuts a year. And these must be whole nuts. The broken ones are used for cheaper grades. Likewise, in the most expensive candies only perfect fruit in large pieces is used and this is simply chocolate coated. In the next grade the small pieces of fruit are used and these are packed in a sugar filling and then chocolate coated. In the expensive candies pure fruit flavors are used and in the cheapest artificial flavors are sometimes employed.

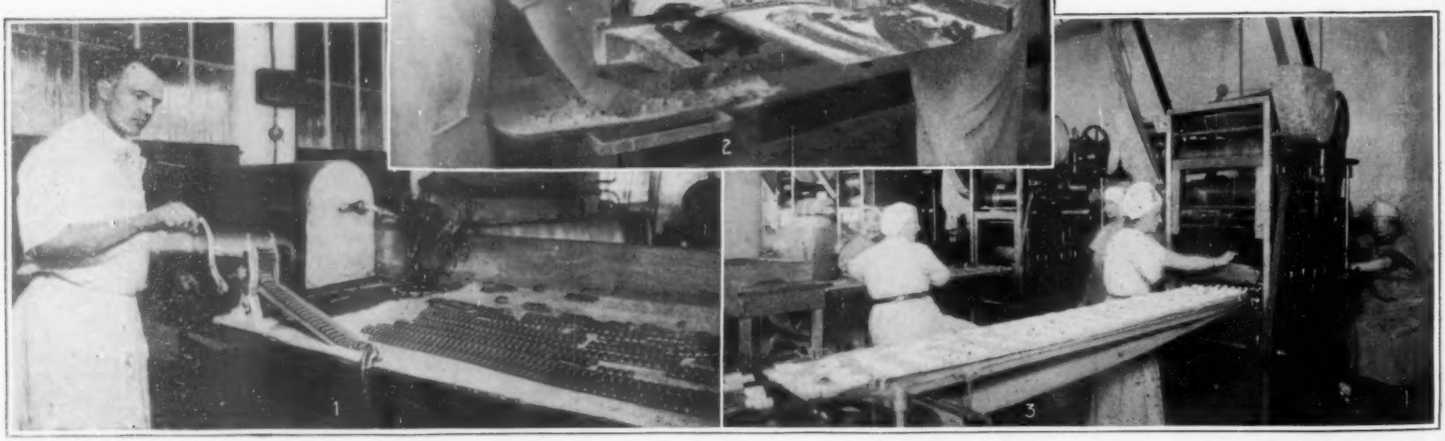
A recent development in the candy business is the great increase in the sale of "unit goods," the tinfoil wrapped pieces that are for sale everywhere at from five to twenty-five cents a package. This has been brought about by the almost total disappearance of "penny goods," due to high prices. The child who once would have been given a penny for candy, now gets a nickel and he usually has to go back after another penny before he can buy anything. The candy makers have invented the "unit package" to satisfy this kind of trade and to tempt the man or woman who just wants something to "nibble at" while waiting for the train or a street car, in the park, or at the corner grocery store.

Perhaps the most striking feature about a big candy factory to the casual observer is the fewness of the big copper cooking kettles or vats. Only a few of these are required to cook the candy for a very large factory and they occupy only a small fraction of the floor space.

Usually the factory is divided into two or three departments, according to the nature of the products. One makes nothing but chocolate-covered candies, another bon-bons and a third "hard candies."

In the chocolate department the most important machine is the "fondant" machine. It makes the fondant or creamy filling that is the base of nearly all chocolates. The fondant, as every home candy-maker knows, is simply sugar and water, cooked to the consistency of very

(Continued on page 94)



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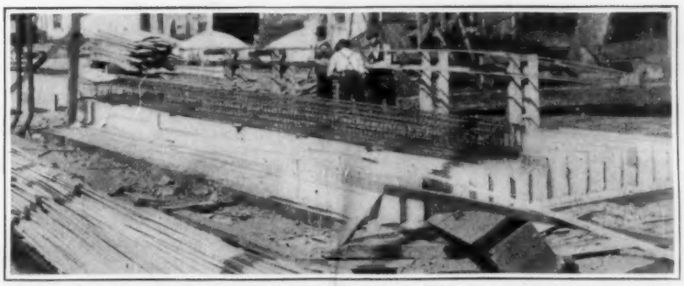
1. Cutting hard candy and spreading it to dry in the breeze from the fan. 2. Converting slabs of nougat first into strips and then into squares. 3. The machine for dipping popular priced chocolates

How modern candies are made on the factory system

Handling the Reinforcing for Concrete Piles

THE accompanying view shows the method of handling the reinforcing in very long piles, as used along the San Francisco waterfront. The reinforcing is assembled on five supports. When ready to be placed in position in the forms, three wooden horses are placed in position. There is a chain hoist on each of the horses, and the hoists are attached to the reinforcing, the reinforcing is raised clear of the supports and then moved to the right to a point directly over the wooden form, and then lowered into position in the form. A one-inch piece of wood is placed under the legs of the horses, so as to tip the horses slightly in the direction in which the reinforcing is to be moved.

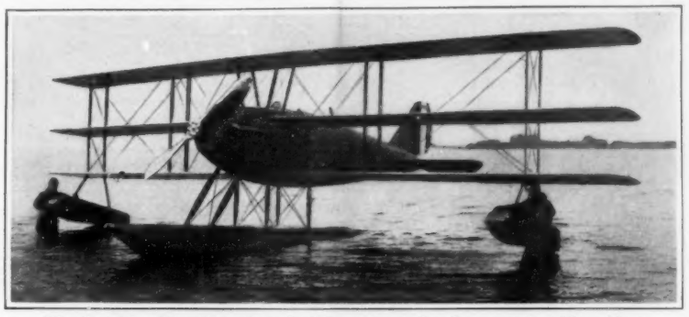


Wooden forms and the supports for handling the reinforcing used in concrete piles

The Fastest in Hydro-Airplanes

THE Curtiss "Wasp," equipped with pontoons, recently established what is claimed to be a new world's record in the Navy trials held at Rockaway, L. I., by traveling at the rate of 138 miles per hour. The 'plane, which is shown in the accompanying illustration, was piloted by Roland Rohlfs, the well-known Curtiss test pilot, and is the same machine in which he established new world's records for altitude and climb at Roosevelt Field last September.

The machine is now the property of the U. S. Navy and will be used at Hampton Roads, Va., for training purposes. The former world's hydro-airplane record was 126 miles per hour, held by the Curtiss HA hydro-airplane. The equipment of the Curtiss "Wasp" is a Curtiss 12-cylinder 400-horse-power engine.

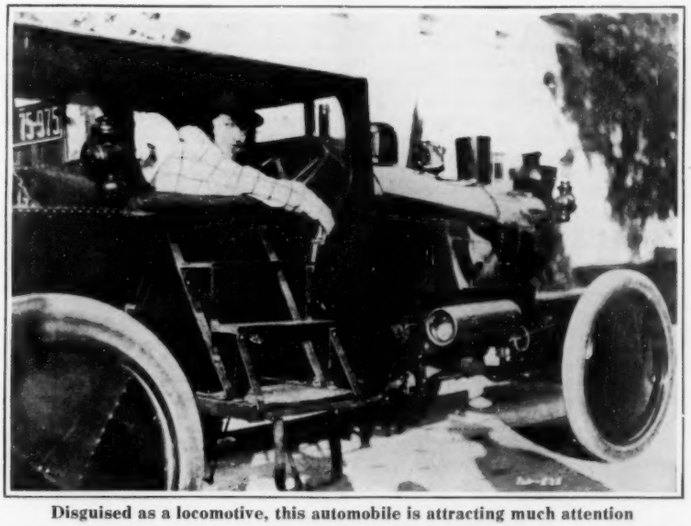


The Curtiss "Wasp" equipped with pontoons for the purpose of breaking the world's hydro-airplane speed records

When a Locomotive Is an Automobile

CERTAIN progressive Californians have gone ahead with novel automobile designs. In fact, while most of us have been contented with such slight modifications as straight-lined bodies or angular mudguards, these Californians have come forth with the road locomotive, which is nothing more than a camouflaged automobile.

As a novelty, the road locomotive is a great success. It goes along the road at any speed, with clanging bell and a shrieky whistle. It undoubtedly gives a new twist or thrill to motoring. Otherwise it has no definite advantages over the usual motor car; if anything, it is more cumbersome and certainly less handsome.

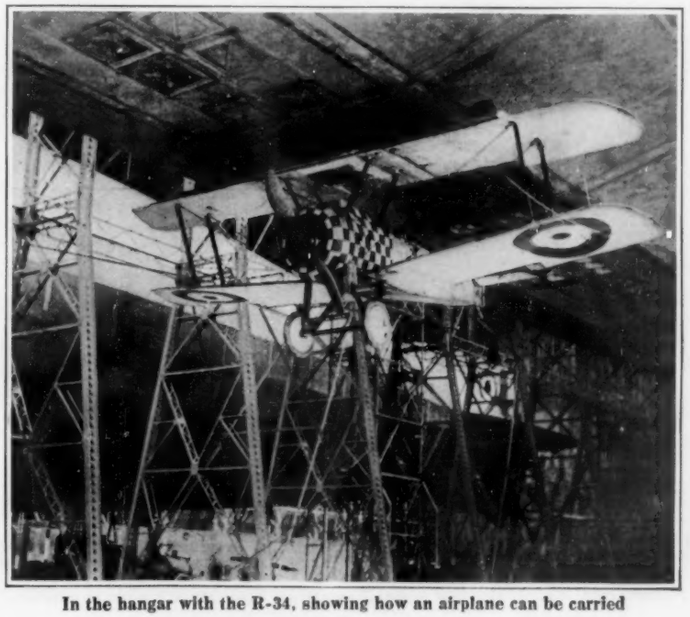


Disguised as a locomotive, this automobile is attracting much attention

Airships That Carry Airplanes

THE helplessness of dirigibles in the face of airplane attacks may be considered a matter of the remote past. It seems that dirigibles of the near future will carry fast, single-seater fighting airplanes along with them for the purpose of defending themselves against airplane attacks.

The British, who appear to have taken the lead in dirigible construction and operation away from the Germans, have been carrying on extensive experiments with airplanes carried by dirigibles. The accompanying illustration shows the giant airship R-34—the dirigible which crossed the Atlantic last summer—in the hangar at Howden, Yorkshire, England, with an airplane suspended below it. The airplane can be reached by passing through a trap-door and down a swinging ladder to the airplane. At the opportune moment the airplane, with motor going at the proper speed, is released from the dirigible and after a very slight drop goes forth on its own flight. The disadvantage, of course, is that once the plane is launched, it is not possible for it to return to the airship, so that the latter will be as much at the mercy of a second attack from hostile planes as under old conditions it was to a first attack. But even immunity from a first attack is something.



In the hangar with the R-34, showing how an airplane can be carried

Aerial Fish Patrol

A PEACE-TIME use for government airplanes has been found that may result in greatly enlarging one of the main industries of the coast states. This is the application of the planes to the location of schools of fish at sea and reporting the discovery by wireless to the canneries.

This new use for airplanes or seaplanes, as the type used in the work are called, first developed but a few months ago, following experiments which were being carried on from the North Island Naval Air Station at San Diego, California. Aviators had commented on numerous occasions upon the ease with which they could discern objects, animate and inanimate, in the depths of the sea.

It was on December 17th that the aerial fish patrol was officially organized at that station and the discovery of schools of sardines was radioed from the planes to the air station, whence word was quickly sent to the fishing fleets in the harbor, with the result that the first four boats to reach the area designated brought in, respectively, 1,165, 4,700, 19,200 and 3,245 pounds of the fish.

A few days later three fishing boats brought in a total of forty tons of sardines, and the success of the venture has continued every day since on which the planes have made their patrol flights.

The ocean in the vicinity of San Diego has been divided into sixty mile squares, as shown upon charts, and each of these squares is divided into ten mile squares. Upon the charts, which are furnished to all the naval air forces operating and to the fishing industries, the larger squares are given designated numbers, and so also are the smaller squares.

When a seaplane, flying at an altitude of some five hundred feet, passes over a patch of water which shows riffles, indicating the presence of a school of fish, the plane drops down closer to the water, where the observer can distinguish the variety of fish below him. If they prove to be sardines, the information is immediately sent by wireless to a subchaser which is usually stationed in the area to be patroled. If the fishing fleets are in the vicinity, awaiting the news, they are advised by means of a megaphone, the number of the large square being given first, followed by the number of the smaller square, with a third number designating the exact spot where the school has been seen. The sub-chaser also radios the information to the mainland, to the State Fish and Game Commissioner, who then advises all of the local fishing industries, the total lapsed time from the discovery until all have been informed seldom exceeding five minutes.

Until the inauguration of the aerial patrol, the fishermen started out with their fleets in the hope of locating schools of fish, but often had to return, disappointed and without a catch, but now the uncertainty has been succeeded by absolute assurance of a successful trip. Canneries which had been idle for some months, for lack of material, have since been running full time, and the canners are feeling more optimistic than ever before. Since genuine sardines are found only in Californian and southern European waters, the impetus which is now being given to the industry in California, through the aid of the government, bids fair to result in making that section the sardine canning center of the world.

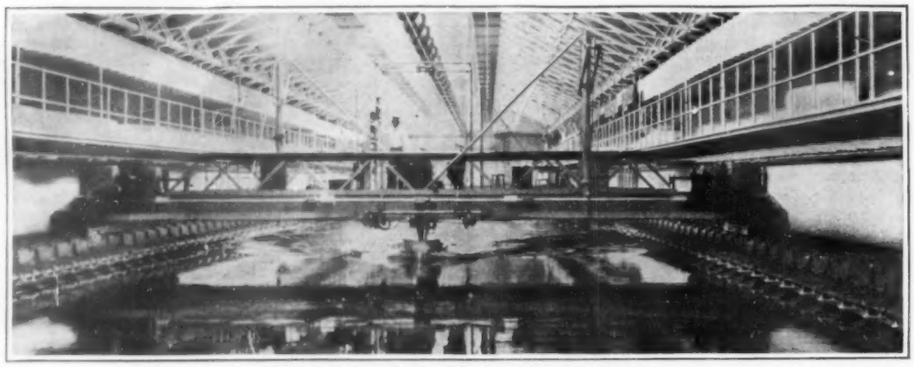
As other fish, of the larger varieties, such as yellowtail, tuna, albacore and amberfish, begin to run, generally from early spring until late in autumn, it is anticipated by the canners that the seaplanes will continue to prove of great value, and that the average annual pack of these larger fish amounting to $2,000,000 in round numbers, will be increased to several times that figure.

Going to Sea in a Tank

Self-Propelled Models That Make for Better Ships and Less Fuel Consumption

By Robert G. Skerrett

IT should be perfectly clear that the vessel which makes the best speed with the smallest fuel consumption is the vessel whose hull and propellers have the most advantageous shapes. It should be equally clear that in such a complicated matter as the shaping of these members, no general formula can ever be derived covering all the ground. The relation of displacement to resistance, of length and beam and other features, may be expressed in general terms. But the "shape of the hull" and the "shape of the propeller" are such complicated matters that we may be quite certain no formula can ever cover all their many ramifications. If we want to see how a certain shaped hull and a certain shaped propeller will behave, we must try it and see.



Full-speed run in the Washington model basin

Obviously we cannot try it on the full-size, completed ship. A disappointing performance would be too costly. So we have the marine model, and the model-testing basin, and for many years we have had these. The practise has been to construct either wooden or paraffin models of comparatively miniature dimensions, corresponding in hull form to the lines of a contemplated full-size ship. The model is then towed beneath a carriage spanning the experimental basin and so attached to a dynamometer mechanism as to record in pounds and ounces the "pull" needful to move the miniature through the water at a speed mathematically proportioned to that of the proposed ocean-going craft.

Without going into details of a technical nature, it should be plain that the towing of an otherwise passive model can furnish data for the solution of only a part of the problem with which the naval architect and the marine engineer must contend. The dynamometer registers the total resistance to be overcome by the model in its progress through the water. This resistance is composed broadly of two dominating factors: first, skin friction set up between the water and the wetted surface of the hull, and second, the force expended in the creation of waves. Of the minor resistances, that of eddy making and certain reactions induced by the propeller are the most noteworthy. By towing independently of the model a thin plate of suitable length and area, representing the surface but not the form of the miniature's underbody, the skin-friction factor is obtained separately, and when this is deducted from the resistance of the model as a whole the remainder is the sum of wave and eddy resistances.

Until within the past three years this was as far as the model basin went in establishing the requirements of propulsive power for any given ship form. Incidentally, the model trials served to indicate the lines upon which the model should be modified to travel with less resistance and, therefore, with a reduced measure of horse-power. But this procedure left a considerable gap in the sequence of desired information. Even though the practise was to place a small propeller in position, subsequently, at the stern of the model, where it could revolve freely during towing, this test gave a very incomplete index of the real relation between the screw and the craft. The marine engineer had to resort to empirical formulæ to approximate the size of the motive plant he would have to build to furnish in actual horse-power enough energy to overcome frictional losses in the machinery, etc., so as to deliver against the water by means of the propeller or propellers the prescribed thrust in the form of effective horse-power. At the same time, he could not choose precisely the design of screw best fitted to translate the engine's drive into efficient effort upon the enveloping fluid.

The experts realized that they could go forward much more confidently in predetermining what a full-size vessel would do if her model could be tested both by towing and by self-propulsion. In the latter case it would be possible, with suitable apparatus, to choose the type of propeller best adapted to meet the needs of the particular ship form and speed and at the same time to learn to what extent the efficiency of the screw might be affected by the shape of the neighboring stern. Finally, a self-propelled model would lead to a definite figure covering the actual engine power essential to overcoming the external resistances called into being by the craft when underway.

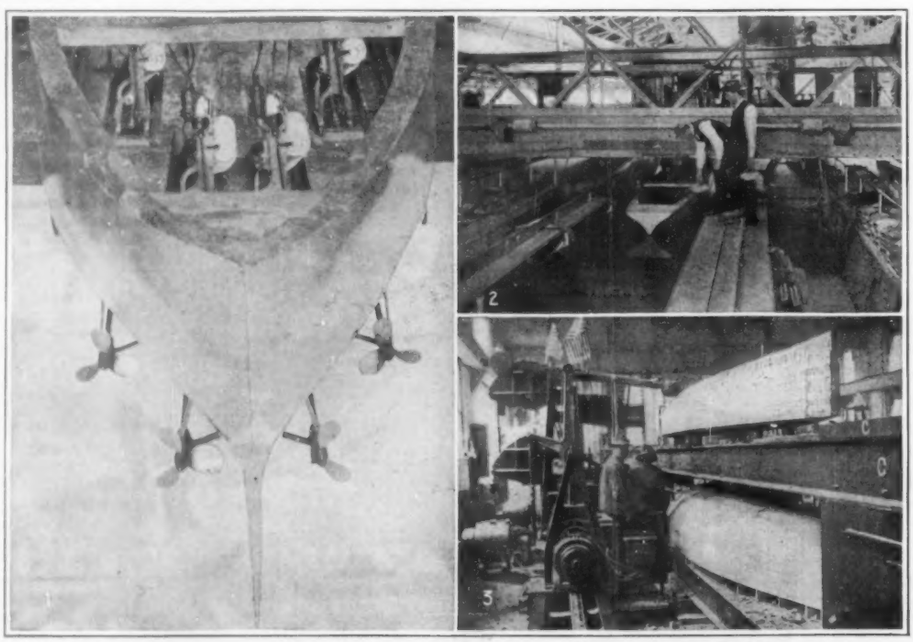
The first experiments along these lines were carried out at the United States Model Basin in Washington in 1918 in connection with designs for single-screw ships. They have since been amplified and used in the testing of models for vessels to be equipped with quadruple screws, such as our gigantic battle-cruisers and our big scout cruisers—not to mention very large transatlantic liners. This research work has been made practicable, thanks to the adaptability of the electric motor and to the facility with which operating current can be measured to a nicety. But before describing the propelling equipment, it might be well to make plain some of the underlying phenomena that bear directly upon the action of the propeller insofar as it tends to increase the water's resistance to a craft's onward motion.

When advancing at considerable speed, a hull encounters resistance which manifests itself in the shape of a bow wave of more or less marked magnitude. A certain expression of this disturbance sweeps sternward, and in a well-designed ship this wave brings its crest just under the counter of the stern section—sweeping in against the vessel's body on both sides, thus inducing a squeezing action that forces her ahead. In this way, the wave of replacement as it is called, offsets the initial check caused by the opposing impulse of the bow wave. The form of the stern may be such as to emphasize or to lessen the helpful effect of the wave of replacement; and the agitation of the water occasioned by the propeller may further impair the beneficial work of the wave of replacement. It can be easily grasped that the churning screws set up, in addition to their greatly agitated eddying wakes, a rush of water toward them from ahead. Clearly, the hull must go forward against this; and with propellers translating a large block of horse-power into drive it is not difficult to grasp the fact that the reactions induced must be of considerable amplitude.

In single-screw models the model is driven by a small direct-current motor connected by means of a flexible coupling to the propeller shaft. The motor's armature shaft, however, is free to move in its bearings, fore and aft, for a distance of 7/16 of an inch, and by this motion to compress a nicely calibrated spring—this action being duly registered upon a revolving drum carrying a strip of paper. In this way, measurements of thrust are recorded in pounds and fractions thereof. Again, the frame of the motor is mounted so as to rotate in independent bearings, and, by another calibrated spring, the tendency of the frame to rotate can be read also in pounds—this figure indicating the torque. Other mechanisms give the factors of time, number of revolutions, the amount of electrical energy consumed, and the speed of the model. Where two, three or four propeller shafts are installed each one is equipped in the manner just described.

During self-propelled runs the miniature ship is not attached to the towing carriage, but is held by it to a straight course through the medium of vertical guide plates 10 inches wide with the edges set fore and aft, which move freely between flanking pins projecting downward from the under side of the carriage. The model can travel independently of the carriage for a longitudinal distance

(Continued on page 95)



1. Looking into a self-propelled model; note the driving motors and the recording cylinders of the dynamometers. 2. Loading a model with bags of shot, before a test, in order to get the desired displacement. 3. The machine that roughs out the experimental models, working on the pantograph principle.

Experimental model ships that propel themselves; how they are made and sailed

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts

Copyright, Kadel and Herbert

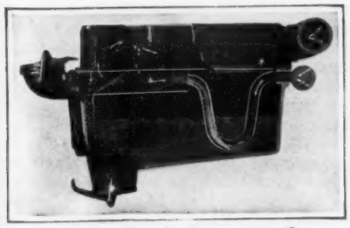
Shining shoes by electricity

The Electrical Shoe-Shine

ELECTRICITY, operating through the medium of the vacuum cleaner and the clothes-washing machine, threatens to put out of business the old-fashioned household worker so far as the matter of supplying elbow grease is concerned. Now the busy little motor is making gestures that indicate a desire to make an end to the business of polishing shoes by force of arm. An enterprising boot-black of 42nd Street, New York, has installed an electric machine that does this, and does it well. So we may expect that eventually the chap who smears blacking on his hands for the purpose of getting the proper fine finish on the shoes of his customers will do so no more, but will be able to carry to work and home again the most elegantly manicured of snow-white digits, if his fancy runs in that direction. As to the machine itself, its construction and mode of action are sufficiently obvious from the photograph and the statement of what it is designed to do. We already have electric buffers and polishers, so it is no great departure to extend their operation to the matter of buffing and polishing shoes.

Air-Washer for Tractor Engines

A NEW device that is somewhat similar in its action to a carburetor is designed particularly for tractor engines as tractors must of necessity work amidst clouds of abrasive particles. The device washes the air by drawing it into the air-washer through a tube and a partial vacuum is created at the lower point of the tube due to its U shape. Water enters the tube at this point in the form of a spray and commingles with the air. The tube is comparatively thin and wide, so that the air currents are subject to the water spray. This mixture leaving the tube is forced to impinge against a plate and as the velocity of the air at this point is rather low, part of the water drops down from this plate through the air stream thus again bringing the air and water into contact. The air then passes upward to the upper separating chamber where, by means of reduction of velocity and baffle plates which are placed there, moisture is deposited and the air passes to the carburetor. The water together with dust particles drops back to the lower chamber. The air-washer is connected to the motor.—By *B. F. Mundorff.*



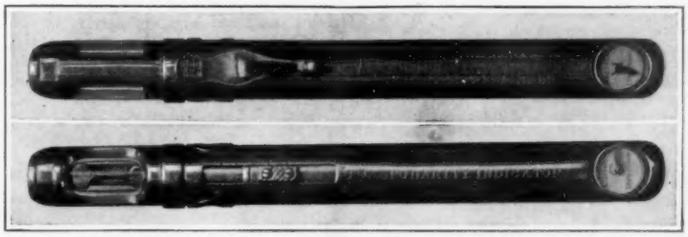
Washing the air that goes to the carburetor

A Four-in-One Trouble Locater

IT is well recognized that most of the time required to locate grounds, shorts and crosses in electrical wiring, motors, generators and appliances by the present crude and wasteful methods is consumed in cutting, disconnecting, reconnecting, splicing, soldering, taping and tagging the wires and leads.

In order to save the repairman practically all of this waste of time and labor, and at the same time supply him with several other indispensable instruments, there has been developed the combination instrument here illustrated.

With it the inventor claims that grounds, shorts and crosses in wiring can be quickly and accurately located without cutting or disconnecting a single wire; and in a motor or dynamo the instrument will show whether the fault is in the terminal-block, the brush-holders, the commutator, the armature coils, or the field coils; also in which commutator segment, on which end of segment, in which field coil, and at which end of coil if near the leads. All this can be done without disturbing a single connection. Grounds inside iron conduit or steel-armored cable can also be located without cutting the wires.



Front and rear views of an electric explorer that does great work in locating trouble

The instrument for this kind of service is used like an exploring-coil when remote from strong magnetic fields, and as an alternating-current galvanometer when near coils or heavy currents.

As an explorer, or current-detector, the instrument is claimed to be considerably more sensitive to small currents of standard lighting frequency than the small commercial and home-made exploring-coils. Furthermore, its indications are visual, and therefore unaffected by noise that would in many cases seriously interfere with the use of a coil.

As an alternating-current galvanometer, the voltage drop in a No. 10 wire with only one ampere flowing can be detected between points less than two inches apart. This is equal to the performance of many millivolt meters.

Additional uses as a detector are to tell alternating-current from direct-current circuits, locating broken-down enclosed arresters, locating idle transformers—due to blown fuses—in multiple or polyphase groups without pulling a fuse and estimating the values of currents too small to be judged by the spark.

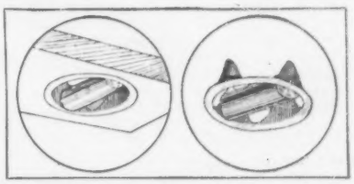
As shown in the illustration there are incorporated in the device a four-in-one combination instrument—a polarity indicator that does not have to be connected into the circuit tested; a compass with improved patented features that can be used in any position; a frequency meter with a range equal to a standard instrument; and an alternating current detector.—By *C. W. Eisemann.*

Curious Cardboard Spectacles

SOME very curious optical effects can be secured with cardboard spectacles cut with various openings. The spectacles are easily formed in this way. Disks of cardboard are cut which measure about two inches in diameter. From copper wire a nose piece is bent as can be seen in the diagram. Each end of this is twisted into a hole made at the side of the disk. In the same way the bows for the ears are formed out of wire. One end of each of these is attached to the edge of the cardboard disk and the other is bent round so that the curved part for going over the ear is formed.

The disks of the spectacles are treated in this way. In one pair a hole is driven with a pin right through the center of each. With another horizontal slits are cut almost from one side to the other of the disks. These should be narrow and they may be cut with a sharp chisel or a penknife. In the case of the other spectacles the slit is of the same nature save that it is cut vertically on the disk.

When wearing the various spectacles some remarkable results are secured. Thus the pair with the pinholes restricts the field of vision but makes distant objects stand up with great clearness. It is possible to read print at three or four times the normal distance with the greatest ease. When wearing the spectacles with the horizontal slits it is only possible to see more or less horizontal lines in houses, fences, trees, etc., really plainly. Thus, while the trunk of a tree is difficult to detect, the horizontal branches are much sharper than is normally the case. Exactly the opposite is the case with the spectacles having the vertical openings. Here it is only the more or less upright lines that are really plain. The horizontal lines are very indistinct and if fine disappear altogether. Thus while one can observe the posts supporting the clothes line it is not possible to see the line itself when wearing the spectacles with the vertical slits.—By *S. Leonard Bastin.*



Roller bearing for heavy furniture, showing attachment and operation

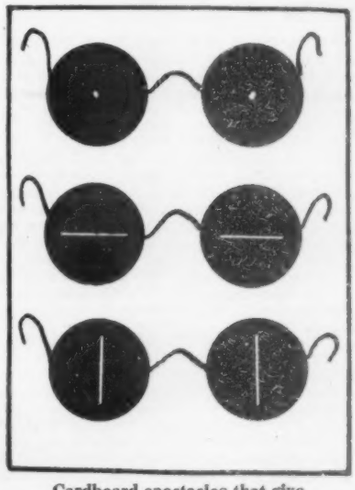
The Jam-less Drawer

A NEW anti-friction roller for furniture that has sliding parts is a simple steel contrivance with a cylindrical steel roller which sets in a circular frame that fits perfectly into a ⅝-inch auger hole and has a flange that holds the roller 1/16 inch above the surface. The device is designed for use as a bearing for dresser drawers, extension tables, and other articles of furniture that frequently cause trouble and give annoyance because of a tendency to stick.

Stainless Steel Kitchenware

TO produce a stainless steel that could be comparatively easily worked and could be used in the manufacture of other articles became the task of metallurgists, and after many experiments they discovered the accurate heat treatment at which it became more workable, and the evolution of many new pots and pans has been the result. The production of this steel is being undertaken in large quantities by all the progressive steel makers in Sheffield, and rustless cooking dishes will soon be on the market. These stainless domestic utensils will have a perpetual appearance of burnished steel no matter what usage they are put to. They may be cleaned by simply being washed in boiling water. They will not readily scale like iron, and their bottoms will therefore not get thin.

The new rustless steel will also be invaluable to engineers and can be used for the manufacture of bolt heads and for similar purposes where resistance to the atmosphere is desired. Engineers are even inquiring into its use for structural purposes, such as for bridges, the necessity of painting which entails enormous and continuous expense.



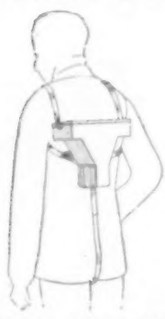
Cardboard spectacles that give strange results

Recently Patented Inventions

Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farming Implements, Etc.

Pertaining to Aeronautics

LIFE SAVING DEVICE.—J. SERETO, 553 6th Ave., Brooklyn, N. Y. The invention relates to a parachute attachment to be strapped to aviators and passengers on aircraft for use in an emergency. The general object is to provide an attachment in which a parachute is held in compact form in a container adapted to be



A REAR PERSPECTIVE VIEW OF THE DEVICE AS STRAPPED TO THE USER

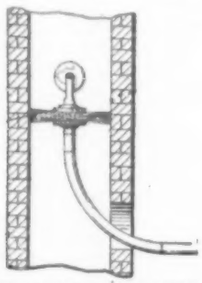
securely strapped to the body of an aviator and in a manner that the parachute may be caused to be automatically and instantly ejected from the container and caused to spread when ejected.

Electrical Devices

ELECTRIC SWITCH.—W. D. THROOP, 198 Laurel Hill, Norwich, Conn. An object of the invention is to provide a quick acting switch operated by a laterally movable or slide member and which can be utilized for higher currents. A further object is to provide a switch which can be manufactured at an extremely low price, which is strong and durable in use.

Of General Interest

CONDUIT CLEANER.—E. HALL, 3974 Scott St., Calumet, Mich. The invention has for its object to provide a device of the character specified, adapted for cleaning pipes of any character, as for instance, flues, drains, and the like, wherein a flexible shaft is provided



A SIDE VIEW SHOWING THE DEVICE IN USE

with a circular brush connected to the shaft to rotate therewith, the shaft having a guiding wheel for properly spacing the brush with respect to the flue and for facilitating the insertion and passage of the brush.

Hardware and Tools

AX.—C. J. KOPRIVA, address A. F. Kopriva, Stony Brook, N. Y. The object of the invention is to provide an ax having an ax head and a removable bit to permit of conveniently and quickly removing a worn out or broken bit from the ax head and to replace such bit with a new one. Another object is to draw the bit securely and accurately into final position on the ax head and to hold the bit in this position against lateral displacement.

Machines and Mechanical Devices

TYPEWRITING MACHINE.—P. ROBLE, address M. Davilla, 644 Carrera 7a. Bogota, Columbia. Among the objects of the invention are to provide a power-driven machine for automatically and serially printing a group of letters and automatically shifting the lines to be printed, to provide means for augmenting and limiting the marginal width of sheets on which the printing is to be executed, to provide a platen whereon paper is arranged for affording increased facilities for proof reading the printed matter prior to disturbing its relation to the printing mechanism, and to provide means for automatically shifting the line-printing thus avoiding interruption of the manual manipulation of the key board.

Musical Devices

HOLDER FOR DISK RECORDS.—F. GRAMMICH, 499 Vandervoort Ave., Brooklyn, N. Y. The general object of the invention is to provide a holder formed of rigid material in the form of a case or container and so arranged as to accommodate a reasonable number of records that may be given back support after the manner of an easel to promote the accessibility of the records and their convenient handling.

Prime Movers and Their Accessories

EXPELLING PIN.—D. J. BELL, 8 Main St., Salamanaca, N. Y. The invention more particularly relates to a tool for removing piston rods from crossheads of an engine. A further object is to provide a substantially heavy pin fitted with an expeller key, which pin may be inserted in the wrist pin bearing of a crosshead and operated to drive the piston rod from its seated position in said crosshead.

Railways and Their Accessories

AUTOMATIC COUPLING FOR FLUID CONDUCTING PIPES OF RAILWAY CARS.—S. A. ROUSSEAU, De Witt, Ark. The invention relates to couplings in railway cars for fluid-conducting pipes, as for instance, air, water (hot or cold), or steam; the object is to provide mechanism which will connect the pipes when the cars are coupled, and will open the valves which are used to close the pipes when uncoupled, and which when the cars are uncoupled will close the valves to shut off the passage of the fluid.

Pertaining to Recreation

AMUSEMENT DEVICE.—J. J. STOCK, 81 W. 101st St., New York, N. Y. This invention contemplates the provision of a tub which shall be capable of movement in a forward or rearward direction, rotation in a clockwise or anti-clockwise direction, or pivoting around one point of its circumference or around a diametrically opposite part of its circumference. A further object is the provision of a tub which shall not be in the least dependent upon the action of an outside machine, but which shall be entirely self-contained, even with regard to its supply of current utilized for operating its power plant.

Pertaining to Vehicles

TIRE FILLER AND TESTER.—C. W. PELTON and J. P. BARBOUR, 215-17 So. Main St., Livingston, Mont. The invention particularly relates to filling and testing automobile tires. An object is to provide a tire air chuck and gage holder combined in one device which when connected with a source of compressed air will deliver the air into the interior of the tire or will cut off the air from the tire and put the latter in communication with the tire gage that the pressure may be readily ascertained; the device is operated by a slight manual movement.

Designs

DESIGN FOR A BUTTON.—J. R. BELLIS, c/o Searing & Moore Co., 24 Beaver St., New York, N. Y.

DESIGN FOR A MEDAL.—A. de LAUTREPPE and H. M. MESRINES, 101 W. 109th St., New York, N. Y.

DESIGN FOR A POWDER CAN OR SIMILAR RECEPTACLE.—C. S. HUMPHREY, c/o Manhattan Can Co., Bush Terminal No. 10, Brooklyn, N. Y.

We wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject-matter involved, or of the specialized, technical or scientific knowledge required therefor.

We also have associates throughout the world, who assist in the prosecution of patent and trade-mark applications filed in all countries foreign to the United States.

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The Last Word in Wireless—The New York Radio Central Station

(Continued from page 79)

machine is to be duplicated and installed in the New York Radio Central Station; but this time there will be two 200-kilowatt machines for each transmitting station—ten in all. The achievement, from a radio engineering standpoint, has nothing approaching a parallel: ten alternators, 2,000 kilowatts, 3,000 horse-power—an astounding force to concentrate in realization of a dream to transmit messages over the world to all points of the compass from a single source.

Mr. Nally emphasized another forward step in engineering which will be incorporated in the super-station. "We will utilize what is termed a multiple tuned antenna, which," he explained, "materially reduces the wasteful electrical resistance of the long, low, flat-top aerials formerly used. A great saving in power is thus effected; in fact, for the same power input formerly used for a single station, six times the effectiveness at a distance is obtained. In other words, we obtain with this antenna the same effect at a distance with 200 kilowatts input as would be obtained from the old type of antenna with 1,200 kilowatts input! This new type of antenna is the equivalent of six independent radiators, all operating in unison at the same wave length, and for the complete station with its five antenna units, the power required will be less than 20 per cent of that formerly necessary. The project, however, contemplates additional possibilities. To illustrate: We may, in many cases, utilize but one-half of a single spoke of the antenna system for communication service to a certain point. On this basis, the Long Island Station will ultimately permit simultaneous transmissions to a maximum of ten points in the world, thus doubling the communication facilities originally planned.

"The receiving aerials are of a new type, too; they have been designed for operation with the Weagant system of 'static' elimination, which, by a combination of opposed electrical circuits, nullifies the long-dreaded effects of atmospheric electricity and makes possible uninterrupted reception from foreign countries under all weather conditions. We break away from a precedent once again in locating our receiving units only eighteen miles from the multiplex transmitting equipment instead of following the former practise of establishing one transmitter and one receiver in one locality and restricting the service of the circuit to one overseas destination."

The arrangements for distant control of the New York Radio Central Station follow the same policy of concentration. In Broad Street, the heart of New York's financial district, the company's public telegraph office is being re-equipped to handle the new station's messages along with the Marconigrams which are now received for England, Norway, Hawaii, and Japan. Thus messages for any of the five additional countries reached by the new station will be received in the New York City office and dispatched direct from a series of operators' keys and relays which will operate the powerful transmitting circuits located miles away out on Long Island. Messages from over the ocean will ultimately be received in the same manner, receipt and delivery of the actual messages being effected by the customary messenger boy service direct to the home or office of the user of the trans-oceanic wireless.

It is expected eventually to install apparatus for high speed transmission and reception, which will be under the supervision of a trained staff of operators along with which there will be the usual staff of expert Morse operators who will work those circuits over which high speed transmission is not taking place.

Descendants of the Water-Wheel

(Continued from page 82)

revolutions per minute, it is estimated that the frictional loss will be about 21 horse-power, which is a very moderate percentage of 42,500 horse-power. The shaft, it will be noted, varies in diameter. At the center of the rotor spider, the diameter is 26 inches. At the location of the thrust bearing it diminishes to 18 inches. The flanges which afford the means of uniting the two parts of the shaft into a single piece are 45 inches in diameter. They are, it appears, forged on to the respective shaft lengths.

It might be thought that the provisions for supplying the air necessary to keep the generator cool would not require much attention. But this would be a mistake. Somewhere in the neighborhood of 80,000 cubic feet of air is required to be passed through this generator every minute that it is operating at capacity. Air is obtained from above and also from the pit below. It passes over the windings and through the center core, and is then discharged into the casing which encircles the stator yoke. It then passes into ducts and by means of auxiliary fans is made to discharge itself outside the station. On top and bottom of the rotor steel plate, centrifugal fans are arranged. In addition to the circulating effect thus produced, is the action due to the poles and the ventilating openings between poles in the rotor rim.

What is perhaps the most powerful high-head, inward flow unit in the world is one which has been installed in the White River plant near Sumner, Wash. Its capacity is rated at 25,000 horsepower. The head is 440 feet and capacity speed 360 revolutions per minute. The unit is a horizontal turbine. That is, the shaft is horizontal, and the conduit which pours water from its inner side through the stationary vanes into the rotating device is arranged in a vertical plane. However, the conduit diminishes in diameter as it circles round, just as in the case of a vertical unit. In the present case the runner is of the double type. That is, it is equivalent to two single runners placed back to back and operated as a single unit. There are two points where the water escapes from the double runner—one to the right and the other to the left. This conduit diminishes in diameter as it rises in front and continues on over to the back. By this arrangement of the conduit, the greater amount of water passes under the runner and the lesser amount over it. Gravitation is thus opposed to good advantage.

While this unit is fairly large, it is by no means so big as the one we have been considering, even comparatively. The horse-power capacity of the horizontal unit is only 23 per cent less than that of the vertical one. It is the high head which enables a big output of power to be realized with a moderate-sized, compact unit.

The problem presented by the conditions of conservation at the White River plant required that the heavy fluctuations in the electric load should be responded to effectively by the water-power system. In short, the water supply giving the high head was adequate to high productiveness of current only in case it was wisely used. The White River supplies the operating water. It derives its supply largely from one of the glaciers on Mt. Rainier. The water after being dammed is led through a heavy wooden flume into a forebay, where it drops its glacial silt. The deposits of silt in the forebay are got rid of by flushing and draining. From the forebay the water is conducted to the reservoir at Lake Tapps. This consists of a natural lake whose water level has been raised some 35 feet. Deepened and enlarged, the lake has a storage capacity of some 2,250,000,000 cubic feet.

(Continued on page 94)

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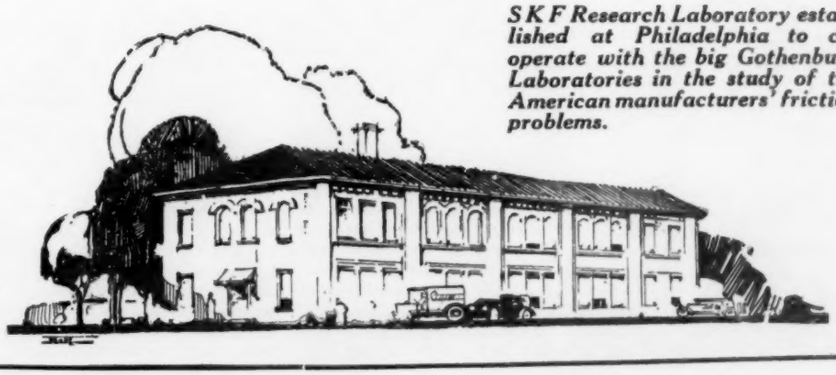

S K F Research Laboratory established at Philadelphia to cooperate with the big Gothenburg Laboratories in the study of the American manufacturers' friction problems.

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Descendants of the Water-Wheel

(*Continued from page 92*)

As this is at an effective elevation of 440 feet above the power plant, it is estimated to represent in electric current about 18,000,000 kilowatt-hours. The water is brought down from Lake Tapps part of the way through a deep open cut and a 3,000-foot tunnel. The cross-section of this tunnel is such as to pass water at the rate of 3,000 second-feet. From the forebay at the lower end of the tunnel, steel pipe-lines carry the water down to the power house. These pipe lines are each about half a mile long and 8 feet in diameter. Sudden changes of the flow of the water through the tunnel and the pipe lines, particularly the latter, might be expected to develop violent variations in the pressures exerted from within outward. Some of the devices employed to meet the requirements are as follows. A surge reservoir was provided at the lower end of the tunnel to prevent surges, due to the tunnel, from causing violent effects in the pipe lines, etc. Then pressure regulators were installed in connection with the turbines of such sort that they release water suddenly when the governor abruptly closes the gates which admit water to the turbines. In order to make the plant responsive to sudden demands for power, air-cushion tanks have been installed. These react quickly upon demand, though naturally they can last for only a short time.

Fifteen Thousand Photographs per Second

(*Continued from page 83*)

tures, one centimeter high, are received on the film, each picture will pose 1/5,000 of a second. Five millimeter views will pose 1/10,000 of a second, and so on. At that speed, the action of daylight is negligible.

We have already seen that M. Bull's installation gives a photographic field of 40 centimeters, same being the width of the luminous pencil. At the initial speed of 200 meters per second, a projectile passes through it in 1/500 of a second and by photographing same each 5/1,000 of a second, ten views can be obtained. It is absolutely necessary that all the various parts of the system work very closely together. As it would be useless to expect an absolute simultaneous action, the shutter must be opened and the series of sparks begun before the moment when the projectile enters in the luminous pencil. The interval should be reduced to the minimum, however, for two reasons: To avoid daylight touching the film for any length of time; and in order not to waste uselessly the loaded condenser which supplies a limited number of sparks, and on the other hand, to prevent the film, which continues to revolve, from being impressed a second time, which would blur the picture. It is therefore necessary to stop the sparks and shut the shutter as soon as the projectile has crossed the photographic field.

These various conditions are attained by means of electric control. The tumbler (or sear) which moves the striking lock of the cannon puts on a contact which opens the shutter during the inflaming of the powder. Another contact, which is caused by the "kick" of the gun, closes the circuit which unites the condenser to the exploding device and the sparks begin immediately. The motor is put in motion at about the same time as the shutter opens.

On a wooden frame placed in the firing axis, several centimeters outside the field, two threads (or wires) are stretched. These threads are cut by the projectile and one of them stops the sparks while the other closes the shutter.

With the electric device we have just described, M. Abraham has obtained 80,000 sparks per second and M. Bull might be able to obtain photographs at that speed, provided the film would move with the required speed. The posing period of each element of the film would always be the same since it corresponds to the time the spark lasts. It is impossible to foresee whether this enormous speed can be used in practice, but it seems probable that M. Bull will not find too many difficulties to exceed largely the rate of 15,000 photographs per second.

Some Observations on Eggs

(*Continued from page 85*)

field, was flooded out during an early June irrigation. There were six eggs in the nest, which the farm children replaced as soon as the water was absorbed. They hoped that the meadow lark would return to the nest.

But the mother bird didn't. After a few excited outcries, as she discovered the irrigation water inundating her, she flew away. The next day the children discovered her building a second nest high and dry on a ditch bank, and a few days later the second nest was supplied with its full complement of eggs.

This meadow lark did what all wild birds do when a nest is robbed or destroyed. In the egg organs of the bird during the hatching season are a large number of undeveloped eggs. The bird ordinarily lays only the regular clutch, one egg to twenty, varying with different birds. However, if a nest is robbed or destroyed, the female bird will immediately proceed to produce more eggs to supply the deficiency. The possibilities in this unnatural stimulation are somewhat undetermined among wild birds, but that the egg-laying faculty is much greater than is generally supposed some authenticated instances show. There is the substantiated case of a flicker, one of the larger woodpeckers, a variety which ordinarily lays a small clutch. The nest of this bird was systematically robbed from day to day, and thus stimulated the female produced 71 eggs in 73 days.

In the light of this faculty, possessed by all wild birds, it is easy to comprehend how the domestic fowl was developed into the great egg layer she now is. Originally, it is fair to presume, wild chickens were simply confined, and their eggs regularly removed. In the course of centuries, as this treatment was continued, egg-laying became more and more a fixed characteristic. In most breeds, poultrykeepers still have to contend with broodiness, a desire to hatch out eggs, which seizes the hen several times in the course of the year. When the hen becomes broody, poultrykeepers "break her up," and if she is a good layer she is soon producing eggs again.

Development of egg-laying in the lightweight breeds, particularly the White Leghorn, has resulted in the practical elimination of broodiness. With the average White Leghorn flock, hatching can only efficiently be accomplished by using broody hens of other breeds or an incubator. It is not practical to attempt to hatch eggs with a young white Leghorn. Few become broody, and those which do are very uncertain setters.

Potentially all our wild birds are egg-layers. In taking the chicken and developing it into the egg machine it now is, mankind probably used the wild bird best adapted to the purpose—which goes further to show that even the farmer's scientific "hunches" are apt to be correct.

Uncle Samuel's Sweet Tooth

(*Continued from page 88*)

thick molasses and beaten until it becomes the creamy filling with which we are all familiar. The sugar and water are cooked in a big kettle and then drawn up into a cooling tank by vacuum. The stuff then passes through water-cooled pipes and drips to a motor-driven beater, which delivers the fondant to vats mounted on hand trucks.

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All good amateur candy makers know that flavoring should be added after the cooking and this is done here. The fondant is taken to steam-heated tables, which keep it soft, and flavoring, nuts and the like are added and the mixture "kneaded" into the candy by the workman. The fondant is then shaped, either by machinery or by hand, according to the quality, and is dipped in chocolate. If the dipping is to be done by hand the fondant passes to girls, each of whom has a puddle of soft chocolate at her side, which she constantly stirs with one hand, while she dips the chocolates with the other. As her hand leaves the finished piece, she draws up a tail of the chocolate and bends it back over the piece, giving the "finish" with which we are all familiar. The chocolates are left to dry on small squares of embossed waxed paper, so that when they are removed the maker's name has been impressed in the bottom.

If the chocolates are to be dipped by machine, girls arrange the fillings on an endless belt, which carries them to the machine. Here they are transferred to a belt of wire rods and are carried through a slow-moving stream of molten chocolate. The excess chocolate drains off through the belt and is carried again to the top of the machine, where it is remixed and again passes through the belt. As the chocolates pass out the other side of the machine, they are again transferred to an endless belt. Two girls seated at this side of the machine dip their fingers in chocolate and add the "finish" of hand-made chocolates. The belt carries the candies through a slot in the wall to the next room, where the air is so conditioned that they rapidly dry. Girls remove them from the belt and they are then ready for packing.

Many of the hard candies are molded by a process very similar to that used in a foundry. The molds are made of starch, into which a pattern has been pressed. The candy is run into the molds from vats, which are steam-heated to keep the candy soft.

In making the familiar hard candy "pillows" the candy is molded into long strips, is run through a heater to soften it and then is cut by passing it between the teeth of two especially made gears. Caramel and nougat cubes are produced by making the candy into slabs and cutting it on a machine which has much the appearance of a buzz saw. The "saw" however is a revolving knife.

The machinery of the candy factory also reveals the secret of making "Jordan almonds." The nuts are placed in a revolving drum about the shape and size of a cement mixer. As this revolves the candy is admitted and the nuts gradually become coated evenly with the delicately flavored hard candy.

Each kind of candy really requires special process and machines and a little department all its own, so it will be seen that a very large output is essential to economical manufacture. The troubles of the maker are complicated by the fact that the demand for candy is seasonal. Thus, we buy and eat nearly as much candy during the months of October, November and December as in all the rest of the year. This problem is met by the maker of cheap candies by producing candies of a kind that will keep well and storing them for the busy season. The maker of expensive candies must sell his product quickly, however, because his goods become "stale" and unsalable within a short time. He can only meet the difficulty by hiring many workers in the busy months and reducing his force during the rest of the year.

Present high prices, which might be thought to cause a reduction in the demand for candy, are having the opposite effect, candy makers say. We are consuming more candy today than ever before in history.

Going to Sea in a Tank

(Continued from page 90)

of 3 inches; and this play gives the operator the needful leeway in adjusting the speed of the carriage to that of the model—his object being to keep the guide plates clear of the limiting stops. If the guide plates strike the stops, owing to the model and the carriage getting out of pace, then the run does not count.

A series of runs consists of a score or more trips the length of the tank at increasing speeds; and from the data so obtained are plotted curves showing the torque, the thrust, and the revolutions per minute at the several velocities. All models at Washington are 20 feet in length, and, according to the size and character of the proposed vessel, these miniatures have a dead weight of a ton or more. The single-screw models tried out in 1918 had a maximum displacement of 3,774 pounds.

After the self-propulsion tests are made, it is the custom to remove the propeller, and then the motor or motors are driven so as to get readings of the shaft friction and the amount of thrust in the absence of the screw or screws. The next step consists in attaching the model to the towing carriage, and in establishing, by successive runs, resistance data peculiar to the model and independent of the propeller. It is important that these runs be carried out with the model in the same condition as when self-propelled and, also, that the temperature of the water be substantially identical in both series. It seems that investigators have discovered that resistance may be increased as much as 4 per cent for each lowered 10 degrees of temperature of the water, and lessened by each corresponding rise of 10 degrees.

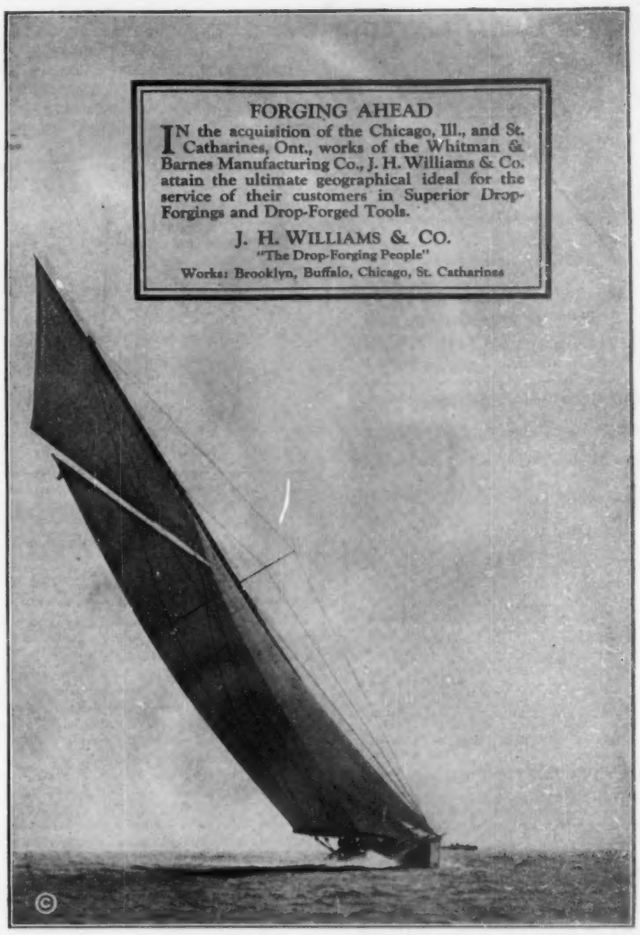
Facts about the characteristics of different designs of screws are secured by testing them apart from the model by runs in the tank. For this purpose there is a special equipment carrying a projecting propeller shaft well forward of the supporting structure so that the screw actually turns in undisturbed water—moving ahead of the driving apparatus. The result of the present method is, therefore, that the screw and the model can be subjected to examination independently and then tried out in combination.

Much added knowledge has been garnered having to do with the efficiency of the propeller agreeably to the surface condition of its blades; and we know today how the screw is affected by the shape of the model and by the state in which the water arrives within the zone of action of the propeller. All of this mass of information is important and bears directly upon the capability of our new-born merchant marine to hold its own in competition with the ships of other nations. The cost of fuel has reached a point where every pound saved in realizing a given sustained sea-speed is of economic moment; and the self-propelled model is aiding us to determine vital facts about a prospective craft's operative charges. We can build ocean-going freighters confidently and be certain that they will maintain their prescribed speeds when burning less coal or oil than many another rival steamer of similar cargo-carrying capacity.

Explosives from Sugar

SOME particulars were recently communicated to the German Chemical Society regarding the process developed during the war by the production of explosives from sugar.

Glycerine was produced from the sugar, the former being used as the initial product for trinitro-glycerine. The process, invented by Connstein and Ludecka, is based on the fermentation of sugar. It was already known that sugar, when fermented, produced minute quantities of glycerine. The inventors found that the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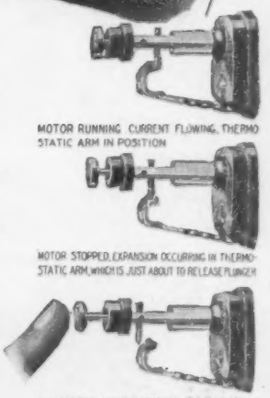
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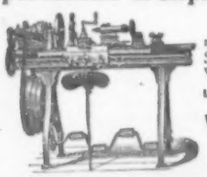

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percentage of glycerine obtained was considerably augmented by adding sodium sulphite to the fermenting bath. To a solution of 1 kilogram sugar in 1 litre of water they added 400 grams of sulphite, 10 per cent of the sugar being allowed to turn into yeast. They then made sure that the yeast cells were properly nourished or propagated. After two days the sugar had completely fermented. By suitably working up the liquid so obtained, a glycerine suitable for all technical purposes was obtained.

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Notes and Queries.

Kindly keep your queries on separate sheets of paper when corresponding about such matters as patents, subscriptions, books, etc. This will greatly facilitate answering your questions, as in many cases they have to be referred to experts. The full name and address should be given on every sheet. No attention will be paid to unsigned queries. Full hints to Correspondents are printed from time to time and will be mailed on request. Please write your queries; do not telephone them, please.

(14332) N. B. asks: I have your book SCIENTIFIC AMERICAN Cyclopedia of Receipts, etc., published in 1892 and have used same with profit many times. It has now gone back on me. I wish to silver a piece of glass 7"x9" for use as a mirror, the silvering to be on the front of the glass instead of the back in order to get rid of the prismatic effect of reflections as seen in the ordinary mirror. I do not seem to find a formula suitable for this. Can you refer me to one in the book or send me one? A. You will find the Brashear process for silvering glass a most reliable one. It is now employed in silvering the large mirrors in the great telescopes. It is No. 10 on page 502 of the SCIENTIFIC AMERICAN Cyclopedia of Formulas. The Draper process is also reliable but is older than the Brashear process. Everything depends upon perfect cleanliness and most careful attention to every detail, else the work will be spotted and worthless.

(14333) H. R. B. asks: A contends that a vacuum exists and also that vacuum has the power to restrain or act as a non-conductor against such an energy as heat. Is he correct in his contention? A. A vacuum is the best insulator against heat which is attainable. A perfect vacuum would be a complete insulator and would retain or exclude heat indefinitely. The common thermos bottle is an example of the use of a vacuum for keeping liquids either hot or cold. Heat is retained in hot liquids and kept out of cold liquids. A is quite correct in his contention. However there is a difference between heat from a white hot body like the sun or an electric lamp and heat from a liquid or solid such as may be contained in a thermos bottle. The intense heat from a white hot body will pass easily through the best vacuum man can make, as witness the heat given off by an incandescent lamp bulb, which will char and set paper on fire. A vacuum will restrain heat of low intensity but not heat of high intensity.

(14334) S. M. R. asks: Kindly settle a dispute we are having in regard to an article contained in the SCIENTIFIC AMERICAN. "A" maintains that the water pumped from the copper mines if placed in a container and tin placed therein that the tin will be transformed into copper. Please be good enough to state whether it is possible by any method to transform tin or iron into copper. "A" claims that an article containing the above to have appeared in the SCIENTIFIC AMERICAN. A. There is no method known to chemists for changing copper to tin or tin to copper. If a copper deposit is made upon tin from water which has been pumped from a copper mine, it is because the water contains some salt of copper dissolved in it and this is by an electrical action decomposed and the copper is plated upon the tin or iron. This may very easily take place. A knife blade dipped into a solution of copper sulphate will in a few seconds become coated with a deposit of copper for the same reasn.

(14335) B. L. P. asks: During the month of September, 1918, I had the privilege of seeing a most wonderful phenomenon. I was compelled to lie out in the sunshine a certain portion of each day and necessarily wore black glasses. One morning, a day or so after a rainstorm, the sky became partially covered with swiftly moving, thin, fleecy clouds. I was turned toward the sun, but protected from its most direct rays by the corner of the roof. Looking at the clouds near the sun, I was startled to see them turning different colors. Thinking perhaps I was just seeing a rainbow on the clouds, I continued to look carefully. But no, the rainbow colors were there—beautiful, soft pastel shades of pink, green, blue, lavender, yellow, orange—*but they were not in rainbow formation nor did they appear in the same position twice.*

As the wind caught fragments of clouds, they became so many bits of color, weaving in an out, a veritable kaleidoscope of the heavens. There seemed to be no uniformity of color in reference to the position of the sun, except the clouds nearest the sun were usually a sort of apricot color. But the pinks and blues, green and lavenders all mixed together in a marvelous manner. To make sure I did not dream all this or imagine it, I had my mother and sister each lie in the same place and look through the dark glasses. They both saw the same coloring. Since then I have seen the same phenomenon, but always in the morning when the sky was clear except for these fleecy clouds, and always through dark glasses. Having spoken to a number of people about this, none of whom can explain it, I am writing to you, to see if any one else has had the same experience, or can explain the reason for the color separation. A. Your observation of clouds near the sun forming beautiful colors is very interesting. What you saw were bits of halos from the water drops or perhaps ice crystals of the clouds if the clouds were high enough above the earth to be composed of ice crystals. Halos are usually circles of colors like rainbows, but near the sun instead of on the opposite side of the sky from the sun as a rainbow is. In your case the colors were in the clouds and not in the minute crystals of ice in the open sky. Otherwise the two seem to be similar.

(14336) G. S. DeH. asks: In a discussion with another man who is of a scientific turn of mind, we came to a standstill in regard to the air pressure below sea level. We know that at sea level it is approximately 14.7 lbs. per sq. in. and we know that as we go up on a mountain top that the air pressure grows less. Now the question is, does air pressure grow less as one gets below sea level or does it get greater and if greater what would be the approximate pressure at the center of the earth, also is gravity strongest at sea level or does it increase as one nears the center of the earth? A. The air pressure increases below sea level in a mine shaft or drill hole down into the earth. At about 1,800 feet above the sea the pressure is one pound less than at sea level. The pressure decreases another pound by about 2,000 feet more of elevation. In an open hole like a mine, a drop of perhaps 1,600 feet below sea level would raise the pressure a pound to 15.7 pounds. The layers of air whose weight is one pound per square inch would become thinner as we descend into the earth. What the air pressure would be at the center of the earth we do not know. Air pressure is simply the weight of air resting on a square inch. On the other hand gravity is greatest at the earth's surface, and diminishes as one goes either above or below the earth's surface. The pressure of the rock and earth strata increases as we descend into the earth, just as the air pressure does, because the weight resting on a surface increases as we descend into the earth.

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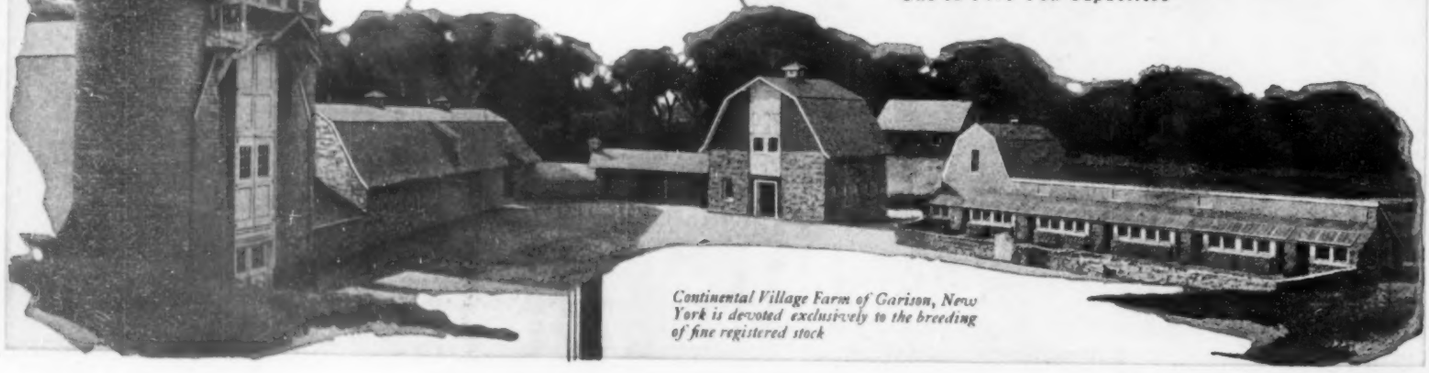

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